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Salinity Control Project Proposal for Dotsero and Glenwood Springs Eagle & Garfield Counties, Colorado

Federal Water Pollution Control Administration

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
Effect of Springs on Users of Colorado River Water	1
DOTSERO SPRINGS	3
Geologic Description	3
Stratigraphy of the Area	3
Structures	5
Dotsero Springs	5
Conclusions	7
Recommendations	7
Flow Discharge and Water Quality of Springs	9
GLENWOOD AND YAMPA SPRINGS	12
Location and Geologic Description	12
Flow Discharge and Water Quality of Springs	12
COLORADO RIVER	12
Hydrologic Characteristics of River	12
Water Quality Conditions	12
Quality of Colorado River with Springs Controlled	14
PROJECT PROPOSAL	16
Control of Dotsero Springs	16
Impoundment and conveyance of springs water	16
Control of Glenwood and Yampa Springs	16
Treatment and Disposition of Water from Springs	16
Treatment facilities at Rifle, Colorado	17
Desalination plant	17
Summary of costs	17
Other Possible Measure for Salinity Control	18
Intercept spring waters by wells	18
Evaporation ponds	18
Sealing recharge areas	18

See Section 27, "Misc Jobs" for review comments and proposed revisions. PS 11-14-70

Page

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS 19

Summary of Control Proposal 19

General Problems 19

Conclusions and Recommendations 20

REFERENCES 21

LIST OF DRAWINGS

LOCATION MAP & AREA PLAN U-306-001

GEOLOGIC SECTIONS U-306-002

GENERAL PLAN U-306-003

SECTIONS, CONTROL PLAN, AND VICINITY MAP U-306-004

INTRODUCTION

According to an inventory by Rouse, most of the salt load contributed by point sources in the Upper Basin occurs within a 15 mile reach of the Colorado River at and above Glenwood Springs, Colorado (1). The springs have been grouped as follows:

	Flow Af/Yr	Load T/Yr	Conc. Mg/L
Glenwood Springs	8,300	213,900	18,880
Yampa Springs	4,700	121,500	18,980
Dotsero Springs	12,300	182,500	10,900
Totals	25,300	517,900	

Effect of Springs on Users of Colorado River Water

The Colorado River Basin Water Quality Control Project prepared a report concerning the economic impact of water degradation (increasing salinity) on users of Colorado River Water. Future penalty costs were estimated for agriculture, municipal, and industrial users below Hoover Dam. Water users in the service areas of the Central Arizona Project and Southern California were also included.

The results of the present and projected salinity concentrations, based on the 1942-61, incl., period of record adjusted to 1960 conditions, are as follows:

Present and Projected Flow Discharge and Water Quality (TDS) for Colorado River at Hoover Dam

	1960	1980	2010
Flow (1000 Af/Yr)	11,313	8,823	8,078
Load (1000 T/Yr)	10,727	10,512	10,880
Conc. (Mg/L)	697	876	990

When the flow and salt load from the springs are subtracted from the above projected values an improvement in quality results. This quality differential is then entered into the economic model for water users (Damage Assessment Model) whereby, the corresponding change in user costs vs. salinity concentrations is calculated. The quality improvement for the removal of the three springs results in a present worth benefit of $27.8 million. Table 1 is a tabulation of the quality improvement and economic benefit associated for each spring.

PROJECT EVALUATION STUDY

PERIOD OF RECORD IS 1942 - 1961, INCLUSIVE, ADJUSTED TO 1960 C

COLORADO RIVER AT HOOVER DAM-	1960	
FLOW -	AF/YR	11312999.
SALT LOAD -	T/YR	10726999.
QUALITY -	MG/L	696.93

PROJECT	FLOW DEPLETION AF/YR	* SALT REMOVED T/YR	* PRE-PRI
GLENWOOD SPRINGS	8300.	213900.	82
YAMPA SPRINGS	4700.	121500.	82
DOTSERO SPRINGS	12300.	182500.	82
TOTAL	25300.	517900.	82

COMPUTATION OF ANNUAL EQUIVALENT VALUE FOR 100 YR PER
AT INTEREST RATE OF 4.875 PER CENT

1968. DOLLARS

PROJECT	ANNUAL BENEFITS OR DETRIMENTS-DOLLARS 1973.	1980	2010
GLENWOOD SPRINGS	609420.	660753.	880752.
YAMPA SPRINGS	347500.	376651.	501585.
DOTSERO SPRINGS	503487.	545826.	727281.
TOTAL	1441287.	1564327.	2091638.

Table 1. Economic Benefits Derived from Control of Saline Springs

PROJECT EVALUATION STUDY

- 1961, INCLUSIVE, ADJUSTED TO 1960 CONDITIONS

DEC 24 1969

ETION YR	SALT REMOVED T/YR	QUALITY AT HOOVER DAM - MG/L PRE-PROJECT	POST PROJECT	CHANGE
00.	213900.	828.21	812.22	-16.00
00.	121500.	828.21	819.13	-9.08
00.	182500.	828.21	815.02	-13.19
00.	517900.	828.21	789.87	-38.34

ANNUAL EQUIVALENT VALUE FOR 100 YR PERIOD
INTEREST RATE OF 4.875 PER CENT

1968, DOLLARS

ANNUAL BENEFITS OR DETRIMENTS-DOLLARS 1980	2010	TOTAL PRESENT WORTH DOLLARS	ANNUAL EQUIVALENT
660753.	880752.	11,745,487.	577,540.
376651.	501585.	6,692,839.	329,095.
545826.	727281.	9,701,097.	477,015.
1564327.	2091638.	27,841,200.	1,368,986.

mic Benefits Derived
Saline Springs

3<

DOTSERO SPRINGS
By Cesar Baez
Geologic Description

Stratigraphy of the area

Rocks that outcrop in the Dotsero area are of pre-cambrian and paleozoic age. The stratigraphic section is illustrated in the U.S.G.S. Bulletin 1142-J, "Geology of Glenwood Springs quadrangle and vicinity." Figure 1 illustrates the lower part of the column and shows the rocks that outcrop around Dotsero.

For the purpose of this preliminary description of the geology of the Dotsero Springs Area, the stratigraphic columns can be simplified as follows:

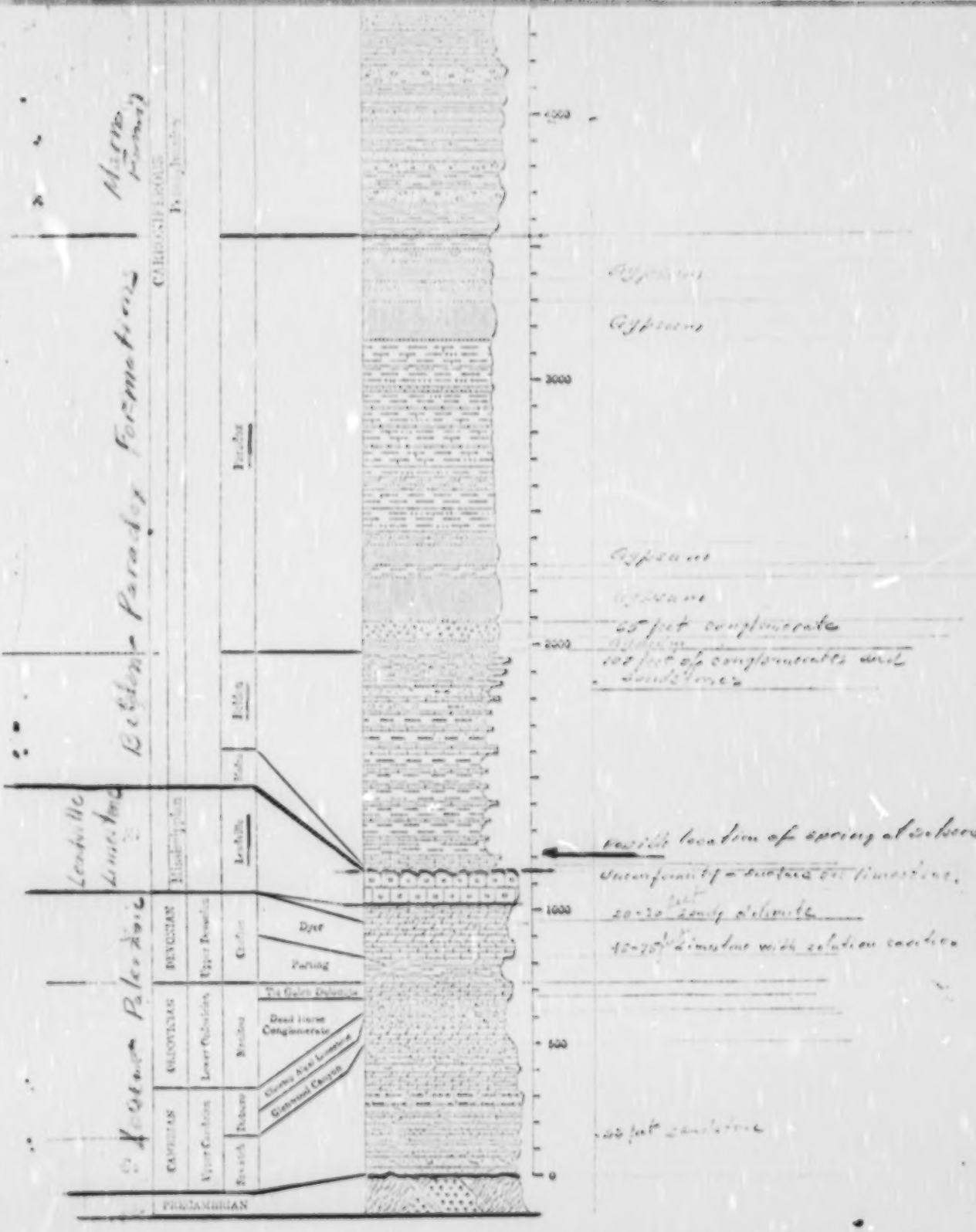
Sandstones of the Maroon formation
Shales and evaporites of the Paradox and Belden formations
Leadville Limestone
Quartzite and Limestones of the Lower Paleozoic age
Granite and Schist of pre-cambrian age

Granite and schist of pre-cambrian age outcrop in the Glenwood Canyon seven miles west of the confluence of the Eagle and Colorado Rivers. Above the granite and schist lie 1000 feet of quartzites and limestones of lower Paleozoic age. According to the description of the constituent rocks, it appears that most of these units would make poor aquifers. However, there are a few strata in this section which could be potential aquifers, these are: 20 feet of sandstone in the Sawach quartzite, 20-30 feet of sandy dolomite, and 48-75 feet of limestone of the Dryer Member of the Chaffe Formations which have solution cavities. Also, there is a 300 foot layer of quartzite in the Sawatch Formation which could be a possible aquifer of low permeability.

The Leadville Limestone is 175 feet thick and has at the base a 3 foot layer of sandy dolomite of low permeability. The top of the Leadville Limestone has an ancient surface typical of the Karst topography. Karst topography is known for providing good ground water circulation.

Lying above the Leadville Limestone is a 2500 foot column of shales and evaporites which includes the Molas, Belden and Paradox Formations.

The Molas Formation is represented by only 9 feet of shale. The Belden Formation is 815 feet thick and is composed mainly of shales, which are poor aquifers. Also, 3 beds of gypsum (some 20-30 feet each) are found in the basal part of this series. Possible aquifers could be at the top.



GENERALIZED COLUMNAR SECTION OF EXPOSED ROCKS IN THE GLENWOOD SPRINGS QUADRANGLE AND VICINITY, COLORADO

Figure 1

of the formation where there are sandstones and conglomerates; these conglomerates and sandstones totals 107 feet in the Deep Creek Section 2 miles north of Dotsero.

The Paradox Formation is 1553 feet thick in a section measured 1-1/2 miles north of Dotsero. It is composed of thick beds of gypsum interbedded with fissile black shales. Also, a solid salt stock over 450 feet ~~were~~ was found in the formation in the area near Glenwood Springs.

The only possible aquifer in the Paradox Formation could be a 65-foot conglomerate. The conglomerate overlies a 38-foot gypsum layer interbedded with shales. This series forms the basal unit of the formation. The maroon Formation which lies above the Paradox Formation will not be discussed at this time.

Structure

Dotsero is located in the west side of a large basin or syncline east of the White River uplift. The Colorado River below the confluence with the Eagle River runs over a secondary syncline structure which raises toward the West (Dwg. V-306-002). The orientation of this syncline compares to the spout of a pitcher wherein the ground water which was collected in the basin above, spills to the West.

Further downstream the Colorado River enters the Glenwood Canyon which is underlain by the quartzites and limestones of lower Paleozoic age; these quartzites and limestones still rise toward the West.

After four miles over this basal series, the river intersects the basement rocks (granite and schist etc.). These rocks also raise toward the west under the quartzites and limestones.

At this point the ground water accumulated from the basin above should find no means to flow outward.

Dotsero Springs

Dotsero Springs flows from the area mapped as the Belden Formation in the U.S.G.S. Bulletin 1142-J.

The discharge from the spring near the culvert under U. S. Highway 6, comes from limestone. The Leadville Limestone formation should be very shallow ~~deep~~ at this location.

The shales and evaporites at the bottom of the Belden Formation have poor physical properties to be good aquifers. Conceivably, most of the saline water could come from the Leadville Limestone and escape

to the surface through fissures or faults in the overlying Belden Formation.

It is likely that much of this saline ground water is seeping into the river within the streambed, especially where the river intersects the Leadville Limestone.

The chemical analysis of the spring water shows a 10,600 to 10,700 Mg/L of dissolved solid and a high content of Na and Cl. There was a variation of 100 Mg/L of T.D.S. in the 3 samples taken during a 1 year survey (from 7/30/64 to 8/12/65). There are no records indicating seasonal changes of the flow discharge.

We may assume that the spring is fed by formation water and that no seasonal recharge of the spring water comes from the river as surface waters from the immediate area.

Control of the discharge of saline water from the springs to the river seems to be possible by dewatering the Leadville Limestone to the extent that the hydrostatic head will remain just below the level of the river bed. The saline water will be used or disposed of in the the more convenient way.

Another spring is located one mile upstream of the previously described spring. The spring flows from a small alluvial fan between the highway and the river. The spring was visited by project personnel on 11/6/64 and the following observations were made:

"The springs near Dotsero were investigated in early afternoon. There appeared to be one main spring where a pit had been excavated and a pool formed. The flow was estimated to be 10 gallons per minute. The conductivity at this spring is about 15,750 micromhos. Upon further examination, however, several other springs were detected. These were numerous and small. It was difficult to estimate the total flow. To complicate matters, it was evident that over an area about 500 yards long and 100 yards wide (approximately) thermal spring water comes to the surface and evaporates, leaving a salt crust over the entire area. While there is not a large continuous flow or discharge to the river, most of this salt is surely washed to the river during runoff following periods of heavy precipitation."

"An intercepting or cut-off trench parallel to the Colorado River or a series of shallow dewatering wells, could be utilized to collect the mineralized spring discharges downstream from Dotsero. Ponding and evaporation could then be accomplished to dispose of the brine for pollution control purposes."

The writer in occasional travel to the area has noticed that the pit is sometimes dry and sometimes full of water. This change may indicate a seasonal recharge in the nearby area.

In addition to the springs already known, it is possible that some springs may flow from conglomerates and sandstones in the upper part of the Belden Formation and the lower part of the Paradox Formation. These sandstones and conglomerates may intersect the Colorado river at several places in the area. The sandstones and conglomerates on each side of the contact between the Belden and Parodox formations are where the river intersects the contact of the Belden - Paradox Formations is clearly shown in the geologic map of the U.S.G.S. bulletin 1142J. The sandstones and conglomerates may be recharged at points of intersection further upstream and could discharge at these downstream intersections.

If a check of these sandstones and conglomerate indicates that there is river water percolating upstream and saline water discharging downstream, consideration should be given to the possibility of sealing the upstream sandstones and conglomerates in the recharge areas.

There is also the possibility that much of the salt contribution could come from erosion and dissolution of sedimentary rocks containing high amounts of salt. Sources of salt can be found in the Belden and Paradox formations in the numerous beds of gypsum and salt. Some of these beds are several feet thick and others are finely interstratified with the shales.

Acclerated erosion of gypsum and salt beds are found in the steep and bare hills along the river valley and in the channel of the Eagle and Colorado River. Solution of the gypsum and salt beds ~~are also found~~ may be found under the alluvial deposits of both rivers.

Corrective measures to prevent erosion and solution of saline sedimentary rocks could be a means of salinity control. The magnitude of the salt contribution from this source and its mechanism processes must first be determined.

Conclusions

Probable sources of salt in the Colorado River in the Dotsero area are:

1/ A large spring which originates in the Leadville Limestone.

2/ Several smaller springs which originate in the sandstones and conglomerates at different levels of the stratigraphic series.

3/ Solution of salt and gypsum from the Paradox and Belden Formations.

Recommendations

1/ Make a detailed geohydrologic study of the Dotsero area to locate the points of discharge of the saline springs, the saline aquifers,

and the salt and gypsum beds of the Paradox and Belden Formations.

2/ Drill and test the saline aquifers.

Cesar Baez
2/16/70

FLOW DISCHARGE AND WATER QUALITY OF SPRINGS

The flow discharge and salt load from the numerous seeps and visible spring outlets have been estimated by deduction 1/. Figures 2α and 2β illustrate a compilation by Ihon's for the 1914-57 period of record and a compilation of a more recent survey by the Colorado River Basin Water Quality Control Project. Water quality data obtained from the latter survey was for the station on the Colorado River above the Eagle River. This data was combined with the U.S.G.S Water Resource data for water year 1964-65. The above two summaries compare very closely. Of further interest for comparison is a dendritic diagram (Figure 3) illustrating the relative magnitudes of flow and salt load contributed by the various sources within the reach.

When using the chemical analysis listed below an inflow of 17 cfs is required according to Rouse (1).

Chemical Analysis of Dotsero Springs

DATE	°C	Cα	Mg	Nα	K	HCO_3	SO_4	CL	$CaCo_3$	TDS	ED	pH
7/30/64		248	53	3690	39	406	429	5760	838	10,600	17,700	7.6
2/26/65		230	62	3790	39	345	478	5840	830	10,700	17,500	7.6
8/12/65	31 (88° F)	270	64	3620	41	464	455	5800	938	10,700	17,300	7.8

He further states that during the survey the observed flow above river level was approximately 6 to 6.5 cfs and it appears probable that the remainder of the flow occurs beneath the water surface in the same area, for a total salt load of approximately 500 tons per day.

1/ The U.S.G.S. estimated that the increase in streamflow between Dotsero and Glenwood Springs is 152 cfs and half of this comes from the drainage area immediately above Glenwood Springs. If the surface flow is 200 ppm and the groundwater inflow is 10,700 ppm, then the groundwater discharge would be about 17 cfs.

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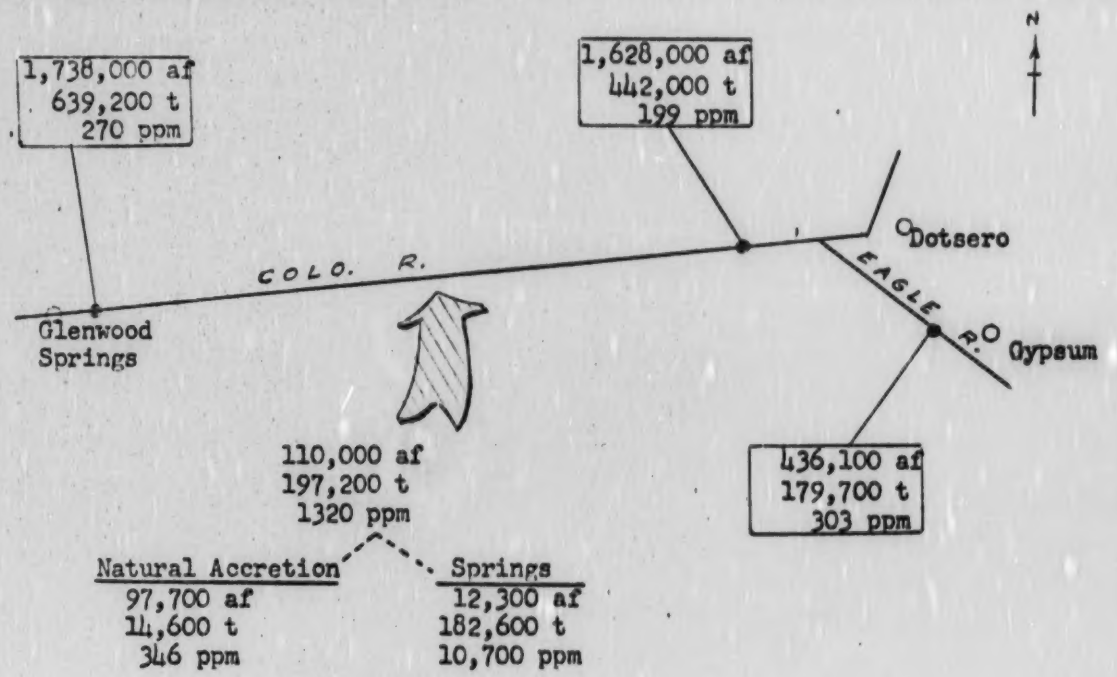


Figure 2a. Colorado River between Dotsero and Glenwood Springs. Iorn's compilation for period 1914-57, adjusted to 1957 conditions.

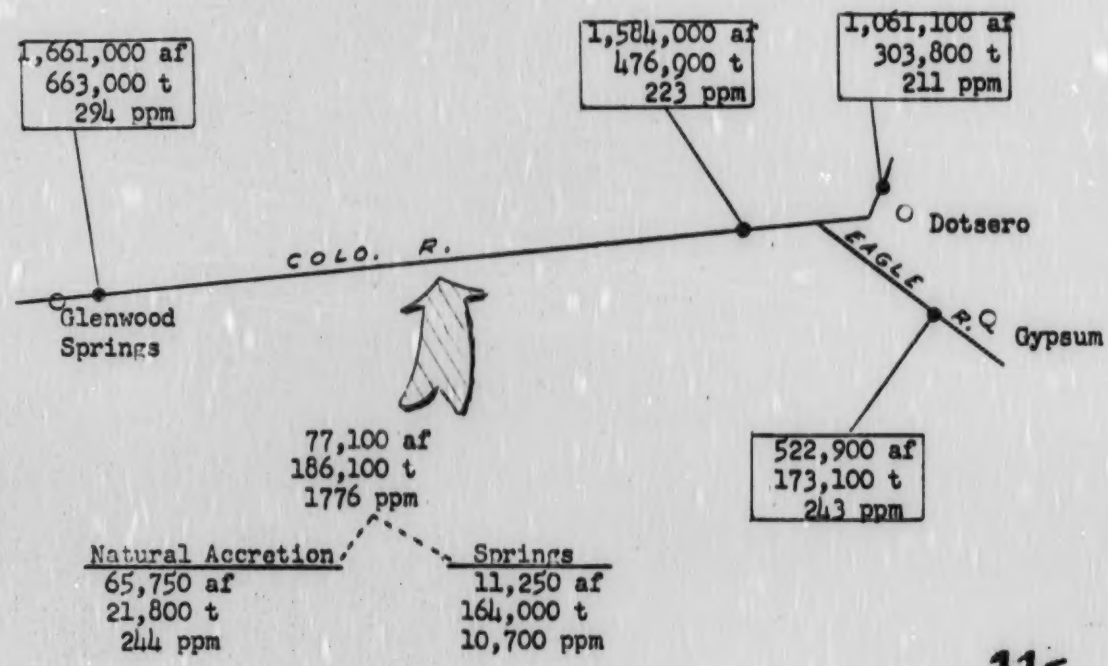


Figure 2b. Colorado River between Dotsero and Glenwood Springs. Water Year 1964-65. CRBWQCP Analysis.

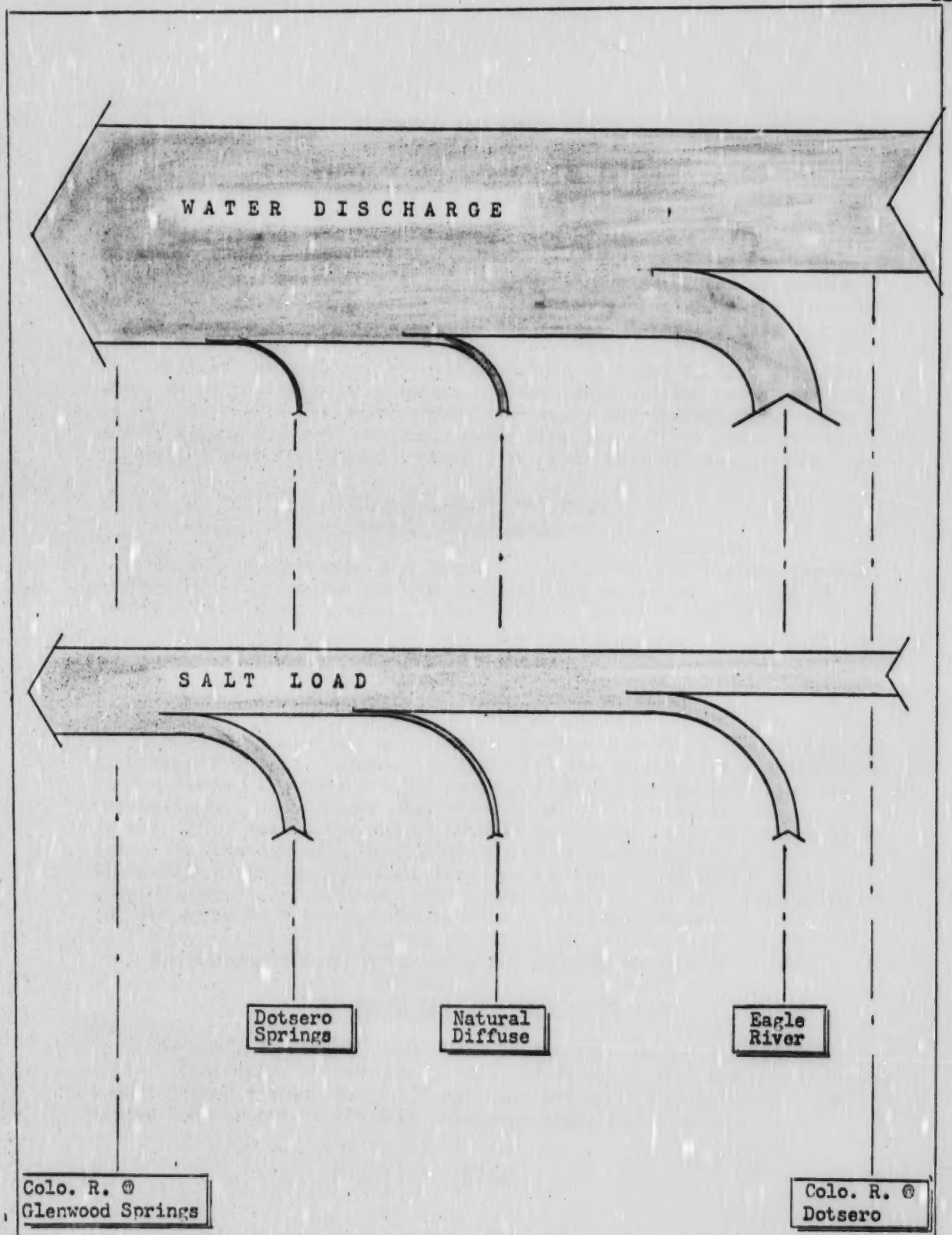


Figure 3. Flow and Salt Load Dendritic Diagram. Colorado River between Glenwood Springs and Dotsero, Colorado.

12<

GLENWOOD AND YAMPA SPRINGS

LOCATION AND GEOLOGIC DESCRIPTION

These springs are located at the town of Glenwood Springs, Colorado, and are aligned along a fault zone that cuts the sandstones, limestones, and evaporites of the Paradox formation of Pennsylvanian age. The high sodium chloride content of the spring discharge indicate a predominance of salt derived from the Paradox formation (2).

Much of the area spring outflow occurs at Yampa Springs (Fig. 4), where it is collected as a supply for the large outdoor swimming pool. It is also reportedly used to heat the nearby Hot Springs Lodge. The wasted spring effluent receives sewage from Hot Springs Lodge and is discharged into the Colorado River just downstream of the heliport (1).

Flow Discharge and Water Quality of Springs

Rouse estimates that the total load addition from mineral springs within this locality is 919 tons per day with an average outflow of 18 cfs. The average concentration of TDS is about 19,000 mg/L

COLORADO RIVER

HYDROLOGIC CHARACTERISTICS OF RIVER

USGS gaging stations are located about a mile above the springs and at Glenwood Springs. Figure 5 illustrates the variability and magnitude of the monthly discharges. The average flow during the past 28 years was 2070 cfs. The maximum flow recorded at the Dotsero station was on June 8, 1952, when a flow of 19,100 cfs passed at a gage height of 11.56 feet. On June 14, 1918, a flow of 30,100 cfs was recorded at the Glenwood Springs station which leads to the conclusion that a flow greater than 19,100 cfs must have passed Dotsero. By direct proportion the discharge at Dotsero would have been about 28,000 cfs.

The minimum discharge recorded was 350 cfs on January 5, 1944.

WATER QUALITY CONDITIONS

The concentration of total dissolved solids varies from month to month. Generally, the concentrations during the winter months and spring runoff period average about 525 mg/L and 200 mg/L, respectively. Concentrations as low as 118 mg/L have been observed in June.

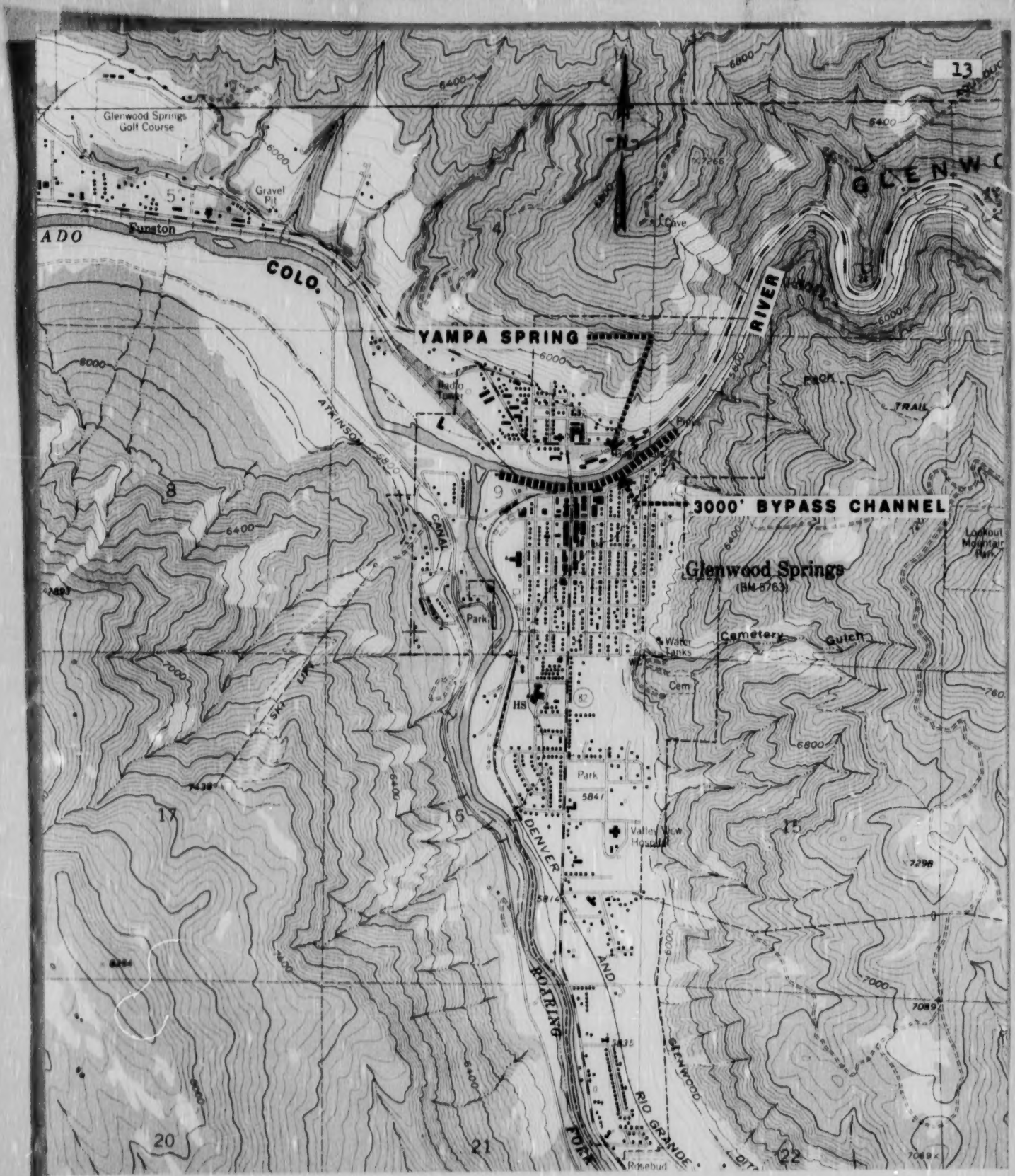


Figure 4. Yampa Spring at Glenwood Springs, Colorado, and Proposed Bypass Channel

~~Figure 5 shows the water discharge and salt load of the Colorado River at Glenwood Springs~~. The cross-hatched ~~portions~~ (see Fig. 2) indicate the assumed base flow where these discharges were assumed to be constant. The graph also illustrates that during the winter months the only discharge is from base flow. Below is a separation of the base flow and surface runoff:

Colorado River at Glenwood Springs (WT 1964-65) (This station is above Glenwood and Yampa Springs)

	Flow Af	Load T	Conc. Mg/L
Base Flow	588,000	420,000	525
Surface Runoff	1,073,000	243,000	166
Total	1,661,000	663,000	294

Quality of Colorado River with Springs Fully Controlled

When the loading from the springs is deducted the following results:

Colorado River above Glenwood Springs with Dotsero Springs Controlled (WY 1964-65)

	Flow Af	Load T	Conc. Mg/L
Base Flow	577,750	256,000	326
Surface Runoff	1,073,000	243,000	166
Total	1,650,750	499,000	222

To evaluate the effects of all three springs the next gaging station downstream will be used.

Colorado River near Cameo, Colorado

	Flow AF	Load T	Conc mg/l
Discharge WY 1964-65	3,152,000	1,634,000	382
Less Springs	25,300	517,900	
Discharge with Springs controlled	3,126,700	1,116,100	262

Thus, the quality improvement of the Colorado River at Glenwood Springs would be an annual average of 72 Mg/L with Dotsero Springs fully controlled. The quality improvement at the Cameo station would be 120 Mg/L with all three upstream springs controlled.

(382 mg/l - 262 mg/l)

(304 mg/l - 222 mg/l)

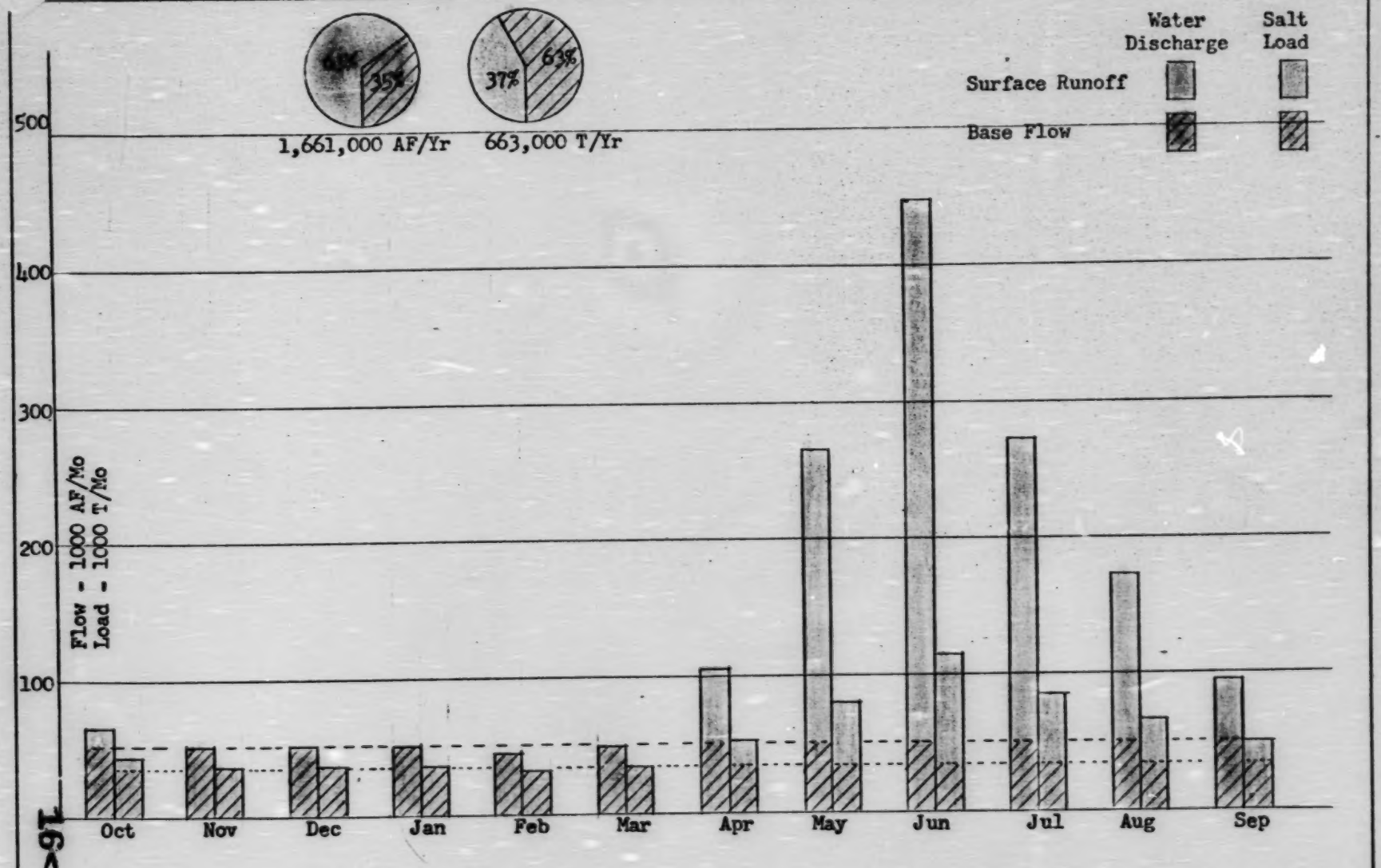


Figure 5. Water Discharge and Salt Load of Colorado River at Glenwood Springs. Water Year 1964-65.

PROJECT PROPOSAL

Control of Dotsero Springs

Several possibilities for control many exist; however, because of the limited knowledge of the nature and magnitude of the springs only one proposal will be investigated. This proposal is based on the assumption that the springs are confined to a one mile reach of the Colorado River (see Dwg. U-306-001). Five arrows are shown on the drawing which represent reported visible spring outlets. A large amount of water is probably seeping upward along the streambed. The geologic profile shown on Dwg. U-306-002 gives strong indication that the limits of the springs are within this reach.

Impoundment and Conveyance of spring water

A bypass channel is shown on Dwg. U-306-003 which diverts and separates the stream flow of the Colorado River over the reach of the springs and seeps. This reach is diked off at each end and the idea is that the water from the springs will accumulate in this impoundment area. Once impoundment has occured, the drain system would fill and the mineral springs water would flow downstream in the pipeline.

The estimated present worth cost for this collection and conveyance scheme is $8.6 million.

Control of Glenwood and Yampa Springs

The same concept of control as for Dotsero Springs is suggested here. A 3000-ft bypass channel would be required with an impoundment area to collect the water from the springs and the outfall discharge from Dotsero Springs (see figure 4).

The estimated cost for the channel and impoundment features is $1.8 million.

Treatment and Disposition of Water from Springs

If all the water from the three springs could be collected and impounded the total volume would be 25,300 af per year. The salt burden in this water would be 517,900 tons.

~~Treatment and Disposition of Water from Springs~~

~~If all the water from the three springs could be collected and impounded, the total volume would be 25,300 af per year. The salt burden in the water would be 517,900 tons.~~

17

TREATMENT FACILITIES at Glenwood Springs

The first attempt to salvage water could conceivably be by desalination located at Glenwood Springs. The city had a population of 3637 in 1960 and demographic projections for the county indicate a highly rapid growth in the future if the oil shale development materialize. The area for the proposed Bureau of Reclamation West Divide Project in Garfield County is expected to expand from 12,000 in 1960 to 229,000 in 1985. The growth trends for Glenwood Springs have not been looked into by this office.

If the per capita consumption at Glenwood Springs is 35 gal/day, then the annual consumption for the 1960 population would be 143 af/yr. With a tenfold increase in population, the city still could not use the salvaged water from the springs. Treatment and use of the water at Glenwood Springs therefore appears to be infeasible.

TREATMENT FACILITIES AT RIFLE, COLORADO

The next possibility would be to convey the spring water downstream by pipeline to Rifle, Colorado, some 26 miles away. According to projections the future population would be concentrated in this area and would have the potential to use all the treated spring water.

When considering this scheme, a 36-inch pipe would be required and this would add another $6.9 million to the total cost.

Desalination Plant

A 22.6 mgd plant would be required to process the waters from the springs. This plant could supply a population of 450,000 at a per capita consumption rate of 50 gpcd.

If the unit cost for treatment were 60¢ per 1000 gallons then the total annual cost would be about $5 million. Revenues from the sale of the distilled water for municipal use could almost offset the above cost rate. However, if the process efficiency is 60% then the sale of the water would have to be greater than $1.00 per 1000 gallons.

Disposal of the brine presents another problem. If the concentration of the brine is in the order of 100,000 mg/L, then 3800 af of water would have to be disposed of each year. The geographic location and climate at Rifle is not favorable for evaporating such a large volume of water; however, it should be noted that a closed basin could be developed about 8 miles northeast of Rifle (see Dwg. U-306-004).

Summary of Costs

The construction costs for the various items mentioned above are summarized below.

18<

Dotsero Springs Collection Facilities	$4.6 million
Pipeline - Dotsero to Glenwood Springs	4.0 million
Glenwood Springs Collection Facilities	1.8 million
Pipeline - Glenwood Springs to Rifle	6.9 million
Total Construction Cost	$17.3 "

OTHER POSSIBLE MEASURES FOR Salinity Control

The above plan represents a simple scheme to impound and convey the water from the springs downstream by pipeline. The advantage of this scheme is that no mechanical features are required and hence the operation and maintenance costs are minimized. The narrow canyon and limited space in the steambed may present some difficulties in the construction of the structures. Consequently, it may be necessary to explore other alternatives.

Intercept Springs Waters by Wells

At Dotsero Springs, the placement of wells could be an alternative worth investigating. The outflow of the springs appears to be predominately along fault line and fractures in the limestone formations. Thus, all these outlets would have to be known before the wells could be made.

Evaporation Ponds

The concept to dispose of the mineral water by evaporation ponds does not appear feasible because of the latitude, elevation, and climate of the area. The surface area required for Dotsero Springs alone is 3300 acres.

Sealing Recharge Areas

This could be a possible control measure at Dotsero Springs. From the description of the geology, recharge areas could be a number of miles upstream. Injection of chemical additives or slurries could perhaps seal the cracks and previous material. If large solution cavaties exist within the formations, then this method would be futile.

SUMMARY AND CONCLUSIONS

Summary of Control Proposal

The rough capitalized cost estimate for construction of this proposal is $17.3 million. Benefits of $27.8 million would accrue to users of Colorado River Water below Hoover Dam if all the springs between Glenwood Springs and Dotsero, Colorado, could be totally controlled.

Mineral quality of the Colorado River at Hoover Dam would be improved 38 mg/L and the quality improvement of the Colorado River below the project area would be 120 mg/L.

The proposal considers treatment of the spring water, which has an average salinity concentratration exceeding 10,000 mg/L, by a desalination plant located at Rifle, Colorado. A 22.6 mgd plant would be required of which this could supply a population of 450,000. The Bureau of Reclamation proposes to construct the West Divide Project in this area. This plan provides for high municipal water use. Demographic projections for population growth based on the future oil shale industry indicate 300,000 people will be residing in the area by 2000.

Should this population growth become a reality, then a desalination plant could possibly be justified. The pure water would have to sold at a rate higher than $1.00 per 1000 gallons. Furthermore, disposal of the brine will be a problem because of the large volume. As an illustration of this magnitude, the volume is 3800 af/yr when the concentration is 100,000 mg/l.

General Problems

Construction of the collection and conveyance facilities would be difficult because of the narrow canyon between Dotsero and Glenwood Springs. Crowded at the bottom of the canyon are the highway, streambed, and railroad. Currently under study are alternative plans to widen the highway to 4-lanes or select a new route over Cottonwood Pass. Another intractable condition is the flow regimen of the river with low flows occuring during winter and high flows in the summer.

The reaches designated as the impoundment or collection areas are subject to the actual location of the limestone formations and the outlet of the springs. If the formations extend further downstream then the structures would have to be extended.

Because of the limited space available for evaporation of the brine waste, other means of disposal will have to be investigated.

Of further problems is the radium present in the effluent waters. Removal of this pollutant obviously would improve the quality of the main stream waters.

20<

CONCLUSIONS AND RECOMMENDATIONS

The proposed collection and conveyance plan appears superficially to have merit. The study was very crude but the purpose was to present the data available and to arrive at conclusions which would give an indication as to the relative merit of constructing a salinity control project. Results of the study indicate a benefit cost ratio of 1.6 to 1.0 and hopefully this will invite further investigations and plan formulations.

To refine the above analysis would require considerable field investigations. It is important to know the nature and extent of the solution caverns and the flow paths of the circulating ground water before definite plans can be formulated. The following are suggested to better evaluate the problem:

Provide for an extensive core drilling and ground water sampling program together with electrical resistivity surveys. As recommended in the Dotsero Geology Description of this report, further field investigations may lead to the source and cause of the springs. Control at the source may be considerably cheaper than the proposal presented herein.

Use remote sensing. Temperatures of the springs are higher than the river water and should show up sharply in infrared imagery. The entire reach between Dotsero and Glenwood Springs, Colorado, could be scanned to determine the extent of the springs.

Soliciting the expertise of the USGS scientists. This would be beneficial in studying the geohydrology conditions of the area.

Solicite the assistance of OSW for the evaluation and feasibility of a desalination plant if a population boom does occur in Garfield County.

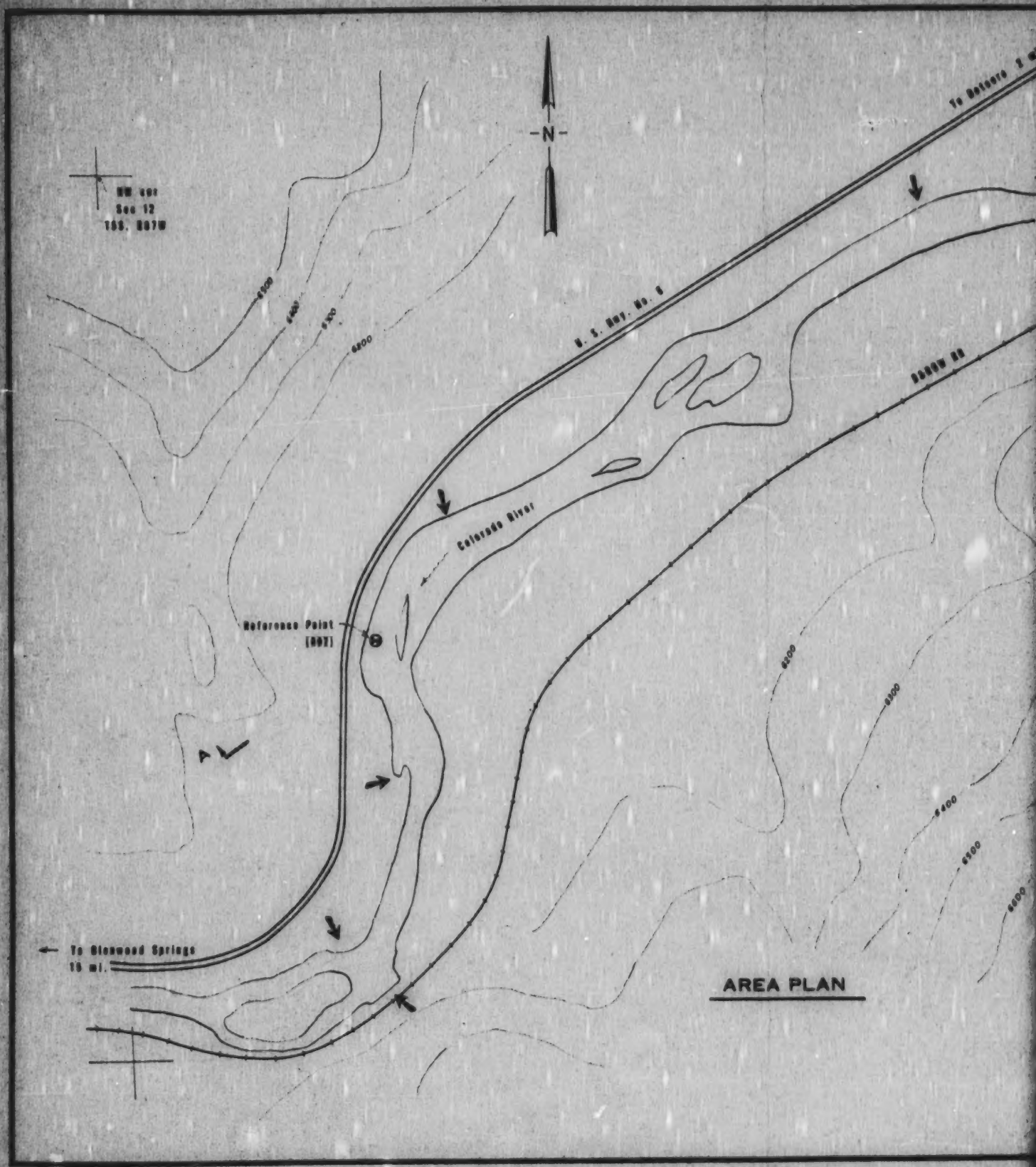
The Bureau of Reclamation would probably be the best governmental organization to prepare the design of the control project.

Only benefits to Colorado River water users below Hoover Dam were considered, but with a quality improvement of 120 Mg/L below the project area it appears that the agricultural users in Grand Valley and municipal users in Grand Junction, Colorado, would also derive benefits. Considerable fruit crops, especially peaches, are grown in this valley. The sensitivity of these fruit trees to increased salinity in the irrigation water should be evaluated to determine if crop yields are affected.

REFERENCES

1. Rouse, J.V., "Mineral Springs and other Natural Paint Sources of Saline Pollution in the Colorado River Basin, January 1967.

2. USHEW, PHS, "Preliminary Salinity Pollution Evaluation & Control Study - Colorado River Basin above Hoover Dam", August 1965, p. 34.


N
NW cor
Sec 12
T6S. R97W
To Delores
U. S. Hwy. No. 6
Colorado River
Reference Point
[RP]
AL
To Glenwood Springs
15 mi.
AREA PLAN

AREA PLAN

Notes

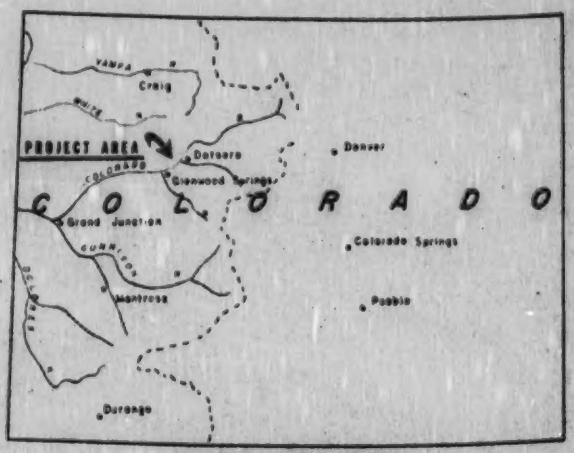
1. Map enlarged from USGS 1:125,000.
2. Project area is in Garfield and Eagle Counties.

Legend

Visible spring outlets

0 500 1000

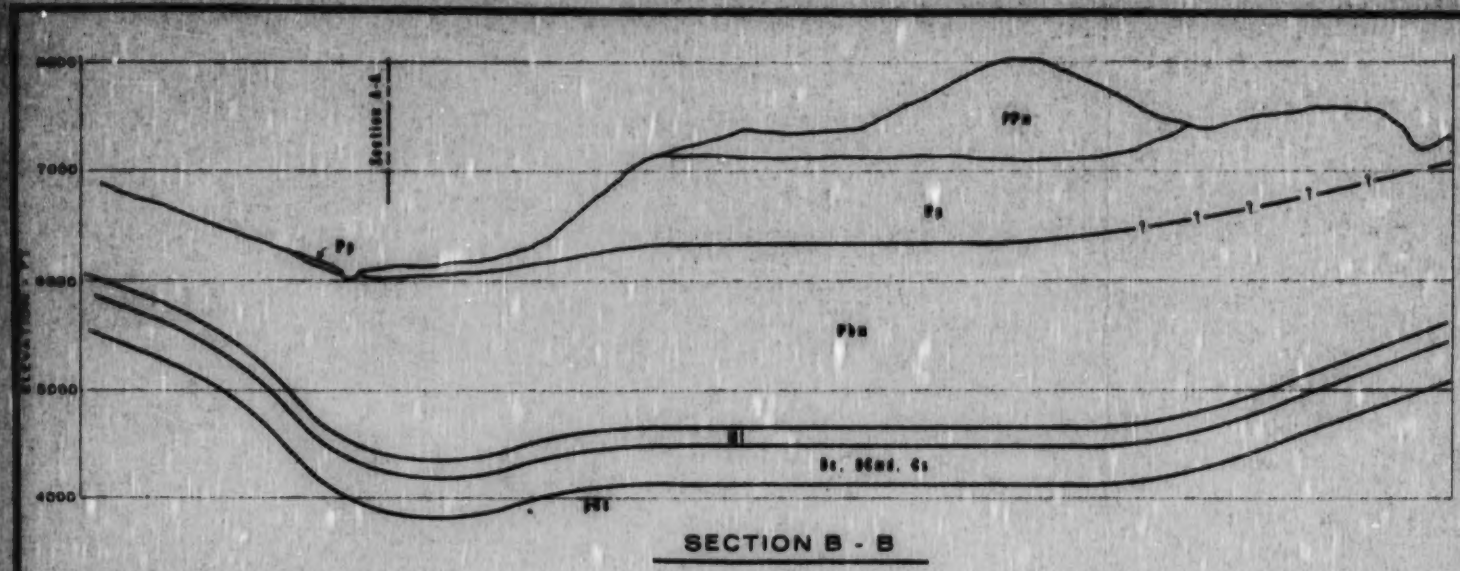
SCALE OF FEET



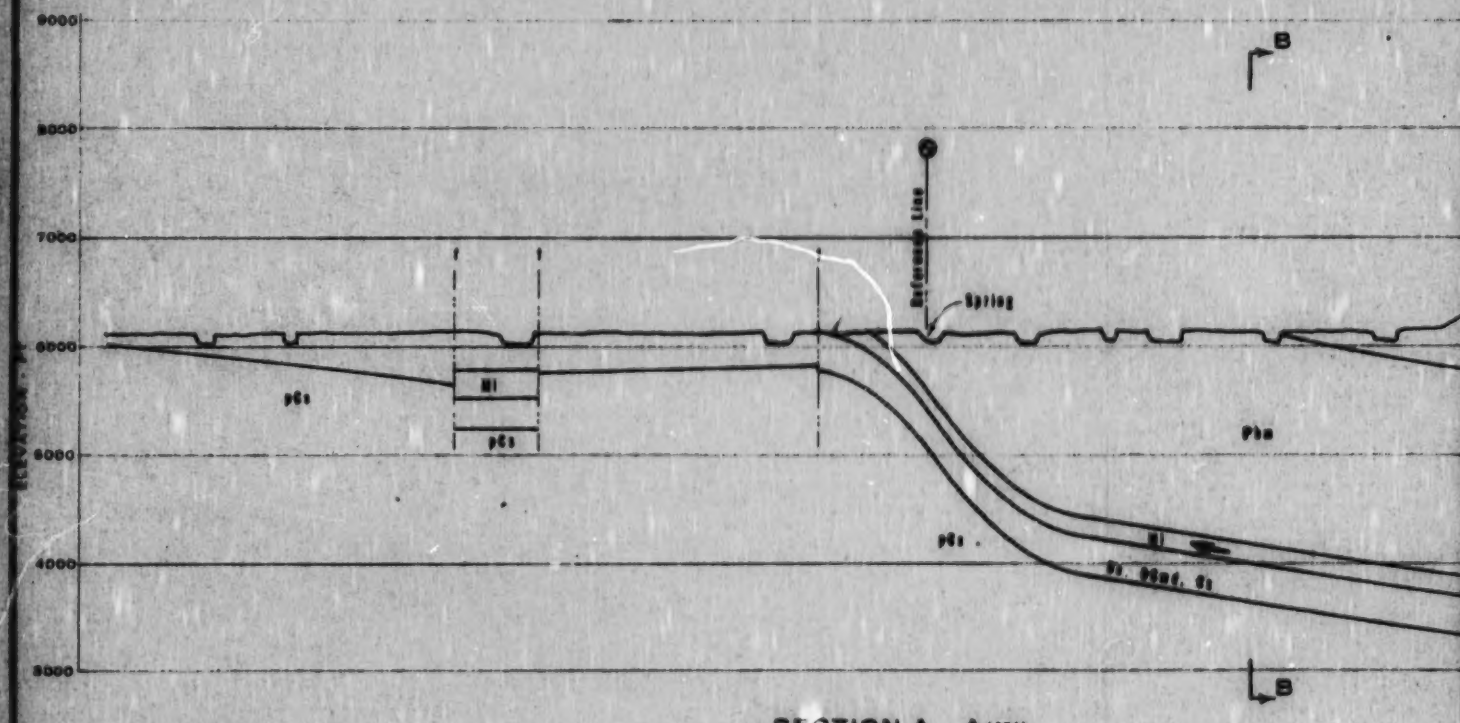
LOCATION MAP

U. S. DEPARTMENT OF INTERIOR FWPCA COLO R-BONNEVILLE BASINS OFFICE	
SALINITY CONTROL PROJECT	
DOTSERO SPRINGS LOCATION MAP & AREA PLAN	
CS 2/12/70	B-388-881

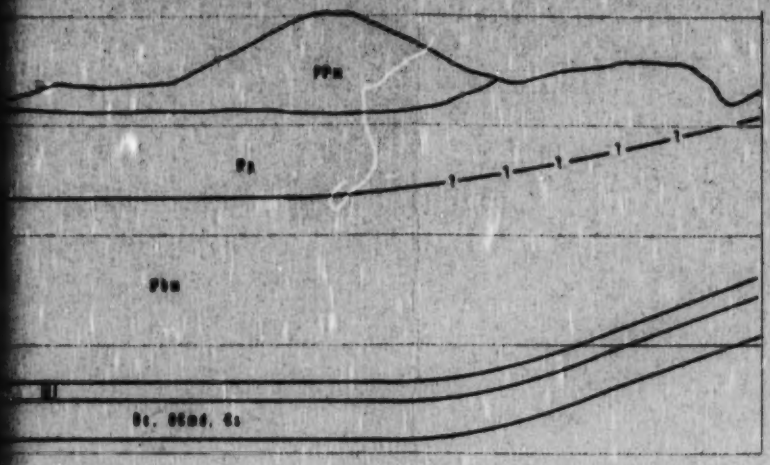
23



SECTION B - B



SECTION A - A (90°)



SECTION B - B

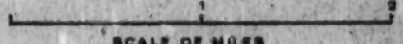
LEGEND

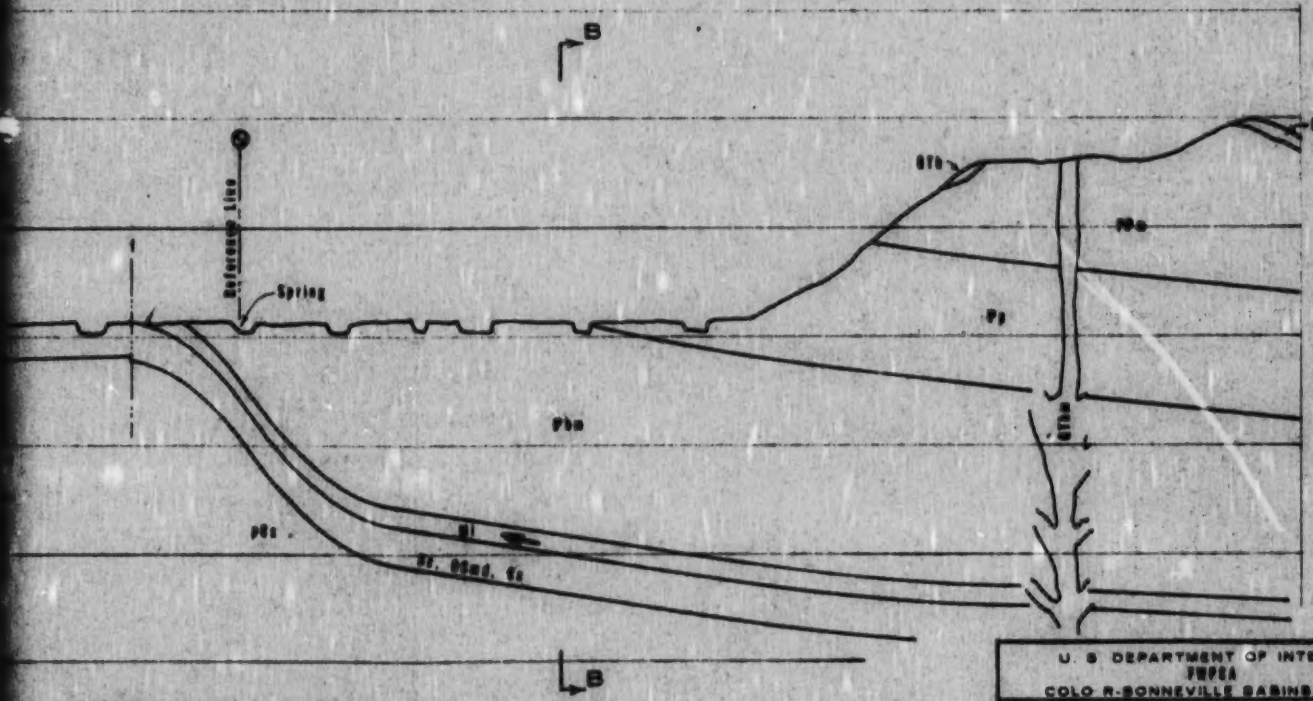
SEDIMENTARY ROCKS

PPm	Maroon Formation
Pp	Paradox Formation
Pbm	Bolden and Molas Formation
Mi	Leadville Limestone
Dc	Chaffee Formation
DSnd	Hanton and Dotsero Formations
Cs	Sawatch Quartzite
pCs	Schist, greenstone, granite and pegmatite

IGNEOUS ROCKS

QTb	Basalt flows
QTbm	Basalt, monzonite ?, and latite ?





SECTION A - A

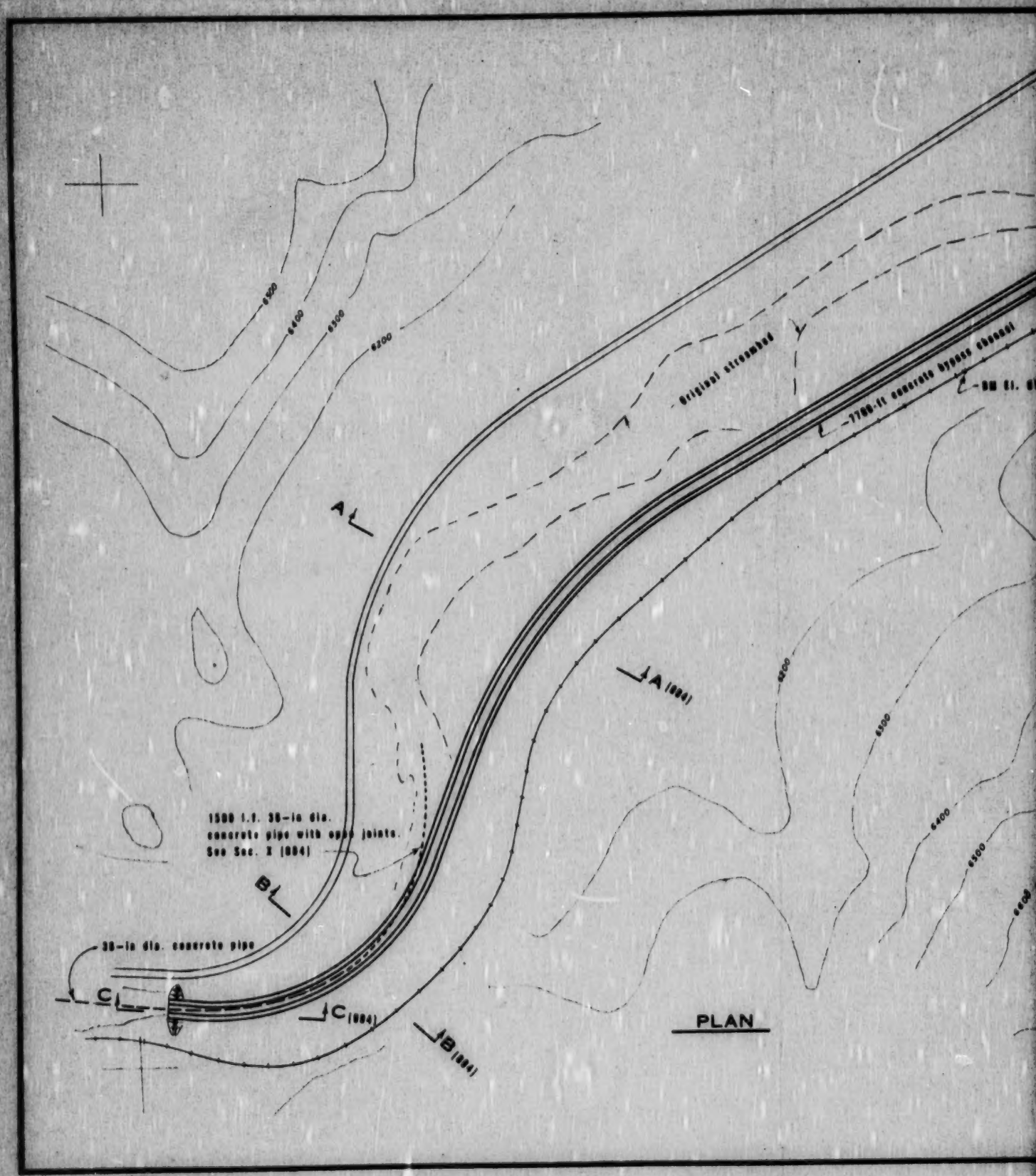
U. S DEPARTMENT OF INTERIOR
FWPCA
COLO R-BONNEVILLE BASINS OFFICE

SALINITY CONTROL PROJECT

DOTSERO SPRINGS

GEOLOGIC SECTIONS

DR. DS 4/21/70 | CHK. | B-388-882


6600
6400
6300
6200
Original streambed
2700-ft concrete bypass channel
A
A (884)
B
B (884)
C
C (884)
1500 l.f. 36-in dia. concrete pipe with open joints. See Sec. X (884)
36-in dia. concrete pipe
6300
6400
6500
PLAN

PLAN

U.S. DEPARTMENT OF INTERIOR
FWPCA
COLO R.-BONNEVILLE BASINS OFFICE

SALINITY CONTROL PROJECT

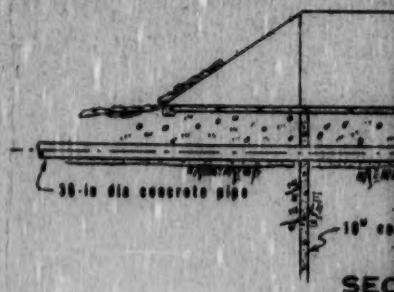
DOTSERO SPRINGS

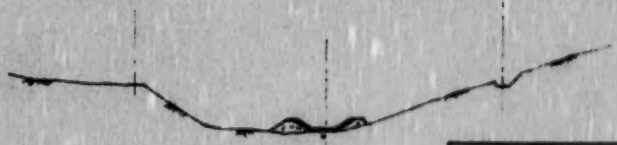
GENERAL PLAN

BL 4/12/70		B-388-603

25

SEC. A-A (883)





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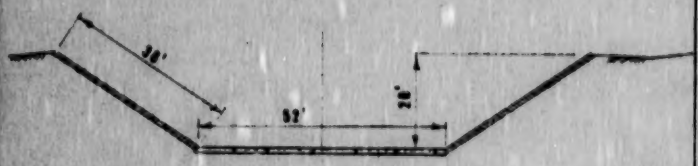
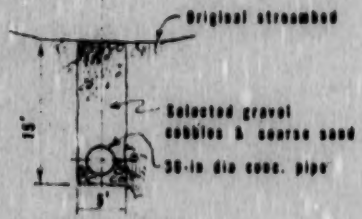


TYPICAL SECTION



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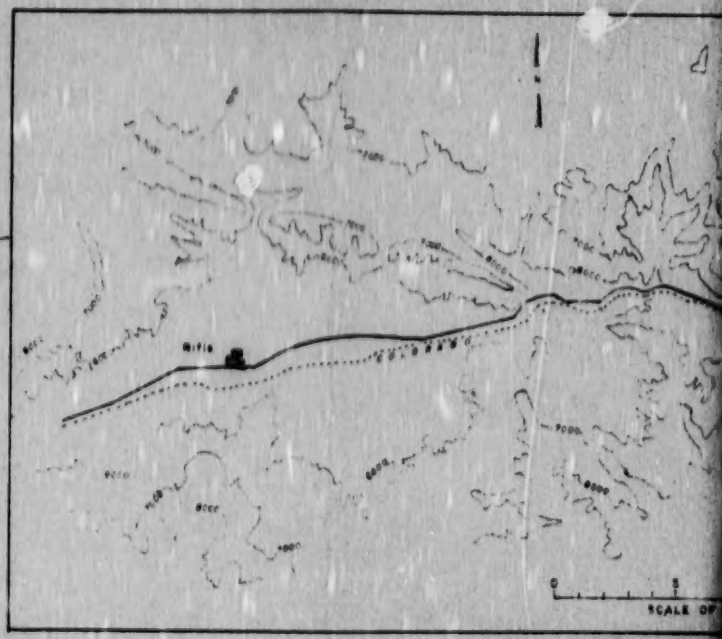


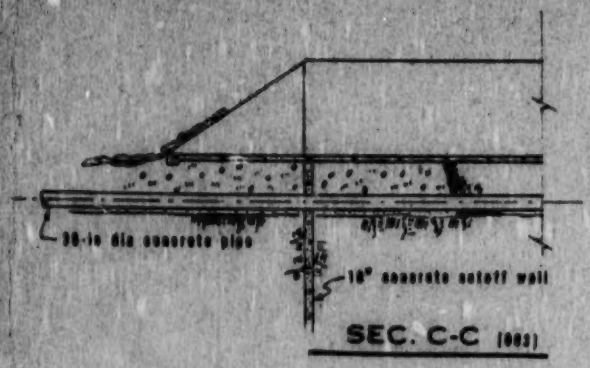
VICINITY

LEGEND

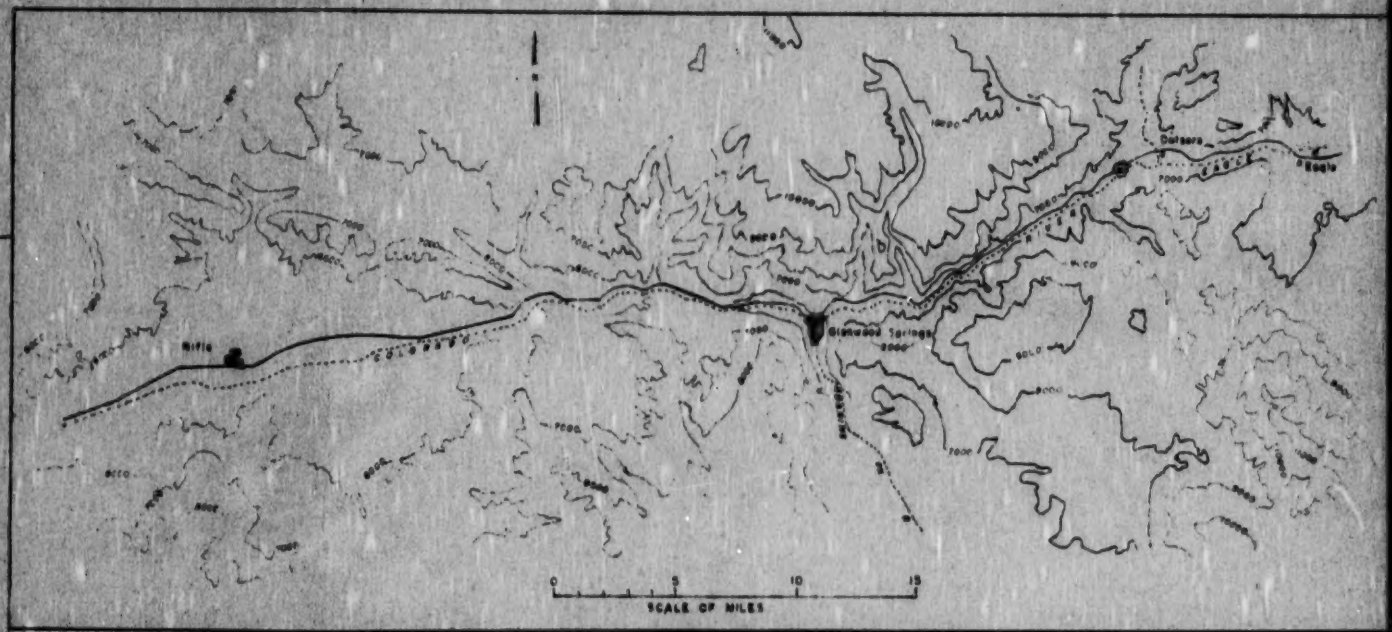
- Impoundment area
- Concrete bypass channel
- Pipeline
- Desilting plant

CONTROL PLAN

SCHEMATIC DIAGRAM



SEC. C-C (883)



VICINITY MAP

LEGEND

- Impoundment area
- Concrete bypass channel
- Pipeline
- Desalting plant

CONTROL PLAN

SCHEMATIC DIAGRAM

U. S. DEPARTMENT OF INTERIOR FWPCA COLO R-BONNEVILLE BASINS OFFICE		
SALINITY CONTROL PROJECT DOTSERO SPRINGS SECTIONS, CONTROL PLAN, AND VICINITY MAP		
AE 6/12/70		S-303-006

FWPCA

COMPUTATION SHEET

PROJECT SALINITY CONTROL PROJECT SHEET NO. _____ OF _____

SUBJECT INDEX BY RS DATE 1/27/70

OFFICE DOTSERO & GLENWOOD SPRINGS CHECKED BY _____ DATE _____

APPENDIX A

	Sheet
Design By-pass channel @ Dotsero	1
By-pass cost estimate	5
Design Conveyance System - Dotsero to Glenwood Springs	7
Conveyance System - Glenwood Springs to Rifle	9
Evaporation Analysis	10
Brine Load from Desalting Plant	11
Time for water to travel from Dotsero to Glenwood Springs	12

APPENDIX B

Data - Colorado River near Dotsero, Colo.

APPENDIX C

Data - Colorado River near Glenwood Springs, Colo.

APPENDIX D

Data - Colorado River above Eagle River

APPENDIX E

Data - Eagle River below Gypsum, Colo

GPO 839 - 170

Design Calculations 28<

APPENDIX A

FWPCA

COMPUTATION SHEET

PROJECT Salinity Control Project SHEET NO. 1 OF

SUBJECT DESIGN BY-PASS CHANNEL @ BY RS DATE 10/23/62

~~OFFICE~~ DOTSERO SPRINGS CHECKED BY DATE

CRITERIA

- Estimated flow of Colo R --
  Max. recorded discharge Colo R @ Dotsero 19,100 cfs (6/8/52), gage height 11.56 ft.
  Max discharge at Glenwood abv. Roaring Fork R 30,100 cfs (6/14/18). Flow on 6/8/52 was 20,800 cfs
  Accretion of flow from intervening area could have been 20,800 − 19,100 = 1,700 cfs
  Therefore, max. flow @ Dotsero might be 30,100 − 1,700 = 28,400 cfs or $\frac{30,150}{20,800}(19,100) = 27,600$ cfs.

- Estimated slope of river --
  BM Elev. @ Dotsero 6150 ±
  " " blw " 6131
  19 ft
  Distance = 16,600 ft scaled
  $\therefore S = \frac{19}{16,600} = 0.0011$

- Calc. est. depth of flow @ max. --
  width of river = 150 ft ± scaled

  Mannings: $\frac{Q}{A} = \frac{1.486}{n} R^{2/3} S^{1/2}$

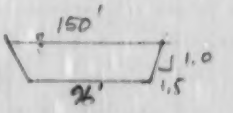
  $\frac{28,400}{A} = \frac{1.486}{0.0225} R^{2/3} (0.0011)^{1/2}$

  $AR^{2/3} = \frac{2.84 \times 2.25}{1.486 \times 3.32} = \frac{6.39}{4.928} = 1297$

  Assume $R = 9$; $R^{2/3} = 4.327$

  $A = 2997$ sf

  $d = \frac{2997}{150} = 20$ ft. -- Try 18 ft



Check: $V = \frac{1.486}{0.0225}(5.749)(0.0332)$

$= 12.80$ fps

$Q = 12.80(2214) = 27,896$ cfs

$A = \frac{96+150}{2}(18) = 2214$ sf

$P = 96 + 2(32.4) = 160.8$

$R = 13.77$

$R^{2/3} = 5.749$

GPO 838 - 170

FWPCA

COMPUTATION SHEET

PROJECT SCP SHEET NO. 2 OF

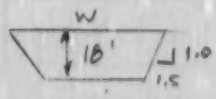
SUBJECT by-pass channel BY PS DATE 10/23/69

OFFICE CHECKED BY DATE

DESIGN CONC. CHANNEL --

$$\frac{28,400}{A} = \frac{1.486}{0.013} R^{2/3}(0.0332)$$

$$AR^{2/3} = \frac{2.84^{V} \times 0.013}{1.486 \times 0.0332} = 7482$$



Assume $R = 12$; $R^{2/3} = 5.241$

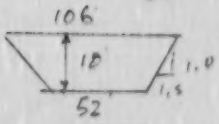
$A = 7482/5.241 = 1428$ sf

$\frac{1}{2}[W + (W - 27 - 27)]18 = 1428$

$2W - 54 = \frac{1428}{9}$

$W = \frac{1}{2}(158.7 + 54) = 106$ ft

Check!



$A = 1422$ sf

$P = 52 + 2(1.8)(18) = 116.8$

$R = \frac{1422}{116.8} = 12.17$; $R^{2/3} = 5.290$

$V = \frac{1.486}{0.013}(5.29)(0.0332) = 20.08$ fps

$Q = 20.08\,(1422) = 28,554$ cfs

Check min flow--

$Q_{min} = 350$ cfs (1-5-44)

Mannings: $\frac{350}{A} = \frac{1.486}{0.013}(R^{2/3})(0.0332)$

$AR^{2/3} = \frac{350(0.013)}{1.486(0.0332)} = 92.1$

$A = \frac{52 + (52 + 3.4y)}{2}(y) = 52y + 1.5y^2$

$P = 52 + 2(1.8y) = 52 + 3.6y$

$y = 1.3$ ft

$A = 70.1$ sf

$V = 350/70.1 = 5$ fps

OK

→ Try $y = 3$ ft

$A = 156 + 13.5 = 169.5$

$P = 52 + 10.8 = 62.8$

$R = 2.704$

$R^{2/3} = 1.940$

$AR^{2/3} = 169.5(1.940) = 329 > 92.1$

Try $y = 1$ ft

$A = 53.5$, $P = 55.6$

$R = .962$, $R^{2/3} = .976$; $AR^{2/3} = 52 < 92.1$

GPO 880-170

FWPCA

COMPUTATION SHEET

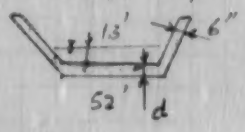
PROJECT SCP SHEET NO. 3 OF

SUBJECT By-pass channel BY RS DATE 10/3/69

OFFICE CHECKED BY DATE

Check buoyancy --

TRIAL 1



$A = 1422 + 116.8(0.5) = 1480$ sf

weight of equiv. volume of water $= 62.4(1480)(1) = 92,352$ lbs.

weight of channel structure $= 0.5(116.8)(1)(150) = 8760$ lbs

$F.S._{uplift} = \frac{8760}{92352} = 0.095$

Add conc. mass @ base to prevent uplift. ($FS = 1.1$).

$92,352(1.1) = 101,587$ lbs total reqm't.

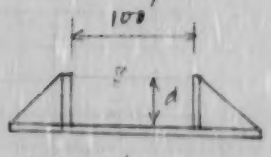
$101,587 - 8760 = 92,827$ lbs needed

depth needed, $d = \frac{92827}{53(150-62.4)} = \frac{92827}{4643} = 19.9$ ft

N.G.

Structure must be redesigned

TRIAL 2
New shape



Determine depth for max flow --

Mannings: $\frac{28,400}{100d} = \frac{1.486}{0.013}\left(\frac{100d}{100+2d}\right)^{2/3}(0.0332)$

$$d\left(\frac{100d}{100+2d}\right)^{2/3} = \frac{28400(0.013)}{100(1.486)(0.0332)}$$

(assume R) $4.7d = 75.0$

$d = 16$ ft

$R^{2/3} = \left(\frac{1600}{132}\right)^{2/3} = 5.278 > 4.7$

$5.278d = 75$

$d = 14.20$

$\therefore d = 15$ ft

$V = 28,400/15(100) = 18.9$ fps

Total depth = 15' + 2' freeboard = 17'

GPO 838 - 170

FWPCA

COMPUTATION SHEET

PROJECT SCP SHEET NO. 4 OF

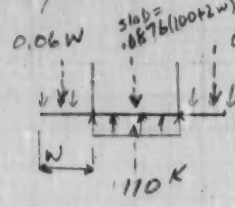
SUBJECT By-pass channel BY RS DATE 10/23/69

OFFICE CHECKED BY DATE

Recheck buoyancy --

$A = 17(100) + 0.5(134) = 1770$ sf

Equiv. volume of water $= 62.4(1770)(1) = 110,448$ lbs



For FS = 1.1, $W = 110,448^{lbs}(1.1) = 121^{K}$

W required -- $2(0.06W) + .0876(100+2W) = 121$

$.12W + 8.76 + .1752W = 121$

$W = \frac{112.2}{.2952} = 380$ ft N.G.

Redesign with rock backfill --

Assume $w = 170$ lbs $- 62.4 = 108$ lb/ft^3 say 100 lb/ft^3 allowing for void space

$2(0.1W) + 0.0876(100+2W) = 121$

$.2W + 8.76 + 0.1752W = 121$

$W = \frac{112.2}{.3752W} = 303$ ft N.G.

Conclusion -- Use originally designed section (Sheet 2). Uplift occurs when water from the springs or runoff accumulates and ponds adjacent to the channel to a depth which completely surrounds the structure. Therefore, a max pool level should be established at the very downstream portion of the reach and that part of the channel would be designed for such an uplift.

32<

FWPCA

COMPUTATION SHEET

PROJECT SCP SHEET NO. 5 OF

SUBJECT By-pass channel @ Dotsero BY RS DATE 12/31/69

OFFICE Cost Estimate CHECKED BY DATE

Mobilization + other

1) Diversion of water at lower end during construction --

Min flow: Oct - Mar $\cong$ 180 cfs

Reach : Sta 0+00 - Sta 26+00

Diversion channel required

$S = 0.0011$

$n = 0.020$

$$\frac{Q}{A} = \frac{1.49}{0.020} R^{2/3} S^{1/2}$$

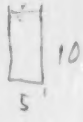
$$\frac{180}{h^2/2} = \frac{1.49}{0.020} \left(\frac{h^2/2}{2.5h}\right)^{2/3} (0.0011)^{1/2}$$

$$\frac{360}{h^2} = 74.5 \left(\frac{h}{5}\right)^{2/3} (0.0332)$$

$$\frac{360}{h^2} = \frac{2.47}{4.19} h^{2/3}$$

$$h^{8/3} = 610$$

$$h \cong 10'$$



section would pass min. flow of 180 cfs

estimated cost = ?

2) channel excavation (22+00 - 77+00)

Area = 52(20) + 20(30) = 1640 ft²

Unit cost = 0.0365(1640)($5/cy) = $300/ft

cost = 5700 × 300 = $1,700,000

33<

FWPCA

COMPUTATION SHEET

PROJECT SCP SHEET NO. 6 OF

SUBJECT By-pass Channel @ Dotsero BY RS DATE 12/31/62

OFFICE Cost Estimate CHECKED BY DATE

3) Channel Structure

$P = [52 + 2(36.2)]0.5 = 62.2$ sf

Unit Cost $1.50 \times 62.2 = \$92./FT$

Cost $= 7700 \times 92 = \$707,000$

4) Appurtenant Features

Cost $= 66.8 \times 7700$

$= \$514,000$

5) Underdrain beneath channel.

Length = 2600 ft

Trenching $= \frac{15 \times 5 \times 2600}{27} = 7210$ cy

excav $= 7210 \times 14 = \$100,000$

select backfill $= 7210 \times 15 = \$108,000$

f&i 36" cmc pipe $= 2600 \times 20 = \$52,000$

Total $= 100,000 + 108,000 + 52,000 = \$260,000$

SUMMARY

Item 2)	$1,700,000	
3)	707,000	
4)	514,000	
5)	260,000	
	3,181,000	
Contingencies @ 25%	800,000	$4.58 million / 7700 ft ≅ $600/FT
	3,981,000	
Engineering @ 15%	596,000	
	$4,577,000	

34<

GPO 839 - 170

FWPCA **COMPUTATION SHEET**

PROJECT SCP SHEET NO. 7 OF

SUBJECT DESIGN CONVEYANCE SYSTEM BY RS DATE 10/27/69

~~CONFIRM~~ DOTSERO - GLENWOOD SPGS CHECKED BY DATE

DOTSERO SPRINGS

Inflow = 17 cfs estimated
Conc ≅ 10,800 mg/L

1) Design flume or pipe to convey spring water to Glenwood Springs (gravity flow)--

$$\frac{17}{0.785D^2} = \frac{1.486}{0.013}\left(\frac{\pi D^2}{4\pi D}\right)^{2/3}(0.0332)$$

$$\left(\frac{D}{4}\right)^{2/3}(D^2) = \frac{17(0.013)}{0.785(1.486)(0.0332)}$$

$$D^{8/3} = \frac{0.221}{0.0384}(2.520) = 14.50$$

$D = 2.69$ ft -- use 36" dia.

Check velocities

$A = .785(3)^2 = 7.065$ sf

$V = \frac{17}{7.065} = 2.4$ fps

Provide storage area for storm runoff and any unexpected temporary increase in outflow from springs--

2) Cost of conveyance system

Length = 15 mi = 79,000 ft

36" RCP = 18.00/LF
Pipe cost = $1,420,000

Installation--
excav in rock 7 x 4 = 28 SF/FT
$\frac{28 \times 79000}{27} = 82,000$ c.y.
excav. cost = $12 x 82,000 = $985,000

35<

FWPCA

COMPUTATION SHEET

PROJECT SeP SHEET NO. 8 OF

SUBJECT Conveyance System BY ES DATE 10/27/69

OFFICE Dotsero – Glenwood CHECKED BY DATE

bedding material $[28 - 0.785(5.5)^2] = 18.4$ SF/FT

$18.4 \times 79000 = 14.5 \times 10^5$ CF

$(.065\ T/ft^3)(14.5)\times 10^5 = 94{,}000$ T

cost = 94,000 @ $3.67 = $345,000

Summary..

pipe	$1,420,000
excav	985,000
bedding	$ 345,000
	$ 2,750,000
25% contng.	690,000
	3,440,000
15% other (longrg, etc)	$ 510,000
	$ 3,950,000

(avg. unit cost $= \frac{3.95 \times 10^6}{7.9 \times 10^4} = \$50/FT$)

GPO 839 - 170

FWPCA

COMPUTATION SHEET

PROJECT SCP SHEET NO. 9 OF

SUBJECT DESIGN PIPELINE - GLENWOOD SPGS BY RS DATE

OFFICE TO RIFLE CHECKED BY DATE

Pipeline - Glenwood Springs to Rifle, Colorado

Length = 26 miles = 13.75×10^4 ft

El. diff. = El. 5700 (Glenwood Spgs) − El. 5200 (Rifle) = 500 ft

Slope = $500 / 13.75 \times 10^4 = .00364$

$Q = 25{,}300$ AF/yr = 35 cfs

Subst. into Mannings -- $$\frac{35}{0.785 D^2} = \frac{1.49}{0.013}\left(\frac{\pi D^2}{4.\pi D}\right)^{2/3}(.00364)^{1/2}$$

$$\left(\frac{D}{4}\right)^{2/3} \cdot D^2 = \frac{35(0.013)}{0.785(1.49)(.0603)}$$

$$\frac{D^{8/3}}{2.52} = \frac{.455}{.0707}$$

$$D^{8/3} = 16.2$$

$D = 2.84$ ft use 36" pipe

cost = $\$50/_{LF} \times 13.75 \times 10^4 = \$6{,}900{,}000$

37<

FWPCA

COMPUTATION SHEET

PROJECT SCP SHEET NO. 10 OF

SUBJECT EVAPORATION ANALSIS BY RE DATE

OFFICE CHECKED BY DATE

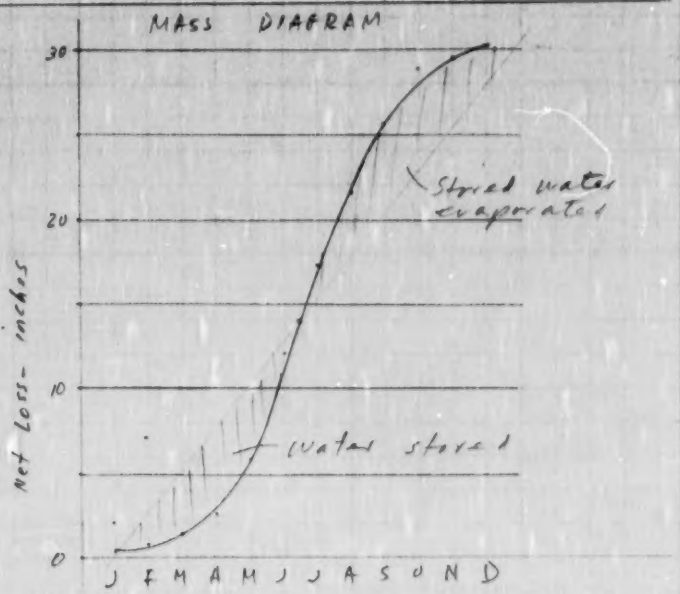
Evap rate (1-1199)

Nov - Apr 10 in ±

May - Oct 34 in ±

Precip = 14 in ±

	Evap. in.	Precip in.	Net Loss
J	1.1	0.9	0.2 -
F	1.5	1.0	0.5 -
M	1.9	1.3	0.6 -
A	2.4	1.2	1.2 -
M	5.3	1.0	4.3 -
J	5.9	0.8	5.1 -
J	6.4	1.2	5.2 -
A	6.3	1.9	4.4 -
S	5.6	1.6	4.0 -
O	4.5	1.2	3.3 -
N	1.8	0.9	0.9
D	1.3	1.0	0.3
	44.0	14.0	30.0



Total volume of springs = 25,300 AF/Yr

Surface area req'd = $\frac{25,300}{2.5}$ = 10,120 Ac.

GPO 839 - 170

FWPCA **COMPUTATION SHEET**

PROJECT SCP SHEET NO. 11 OF

SUBJECT BRINE LOAD FROM DESALTING PLANT BY PS DATE

OFFICE CHECKED BY DATE

Volume of brine --

Salt removed = 518,000 t/yr

If concentration of brine is 100,000 mg/l (136 tof), then carrying water = 518,000/136 = 3800 af/yr

GPO 839 - 170

FWPCA **COMPUTATION SHEET**

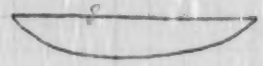
PROJECT SCP SHEET NO. 12 OF

SUBJECT DETERMINE TIME FOR WATER BY RS DATE

~~OFFICE~~ TO TRAVEL BETWEEN DETSERO & GLENWOOD CHECKED BY DATE

① Colo R @ Glenwood

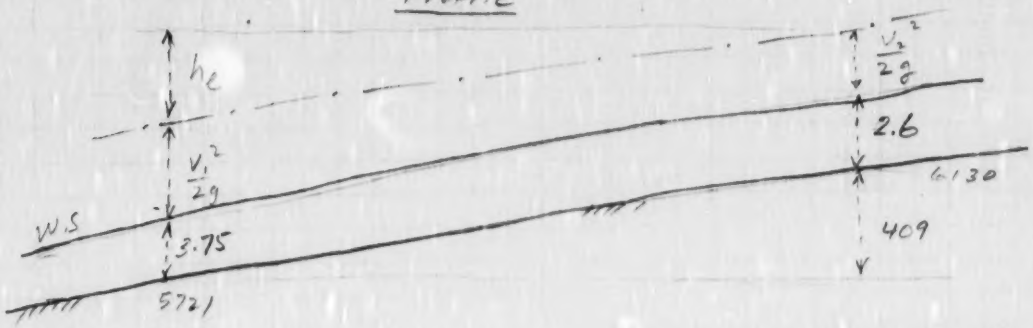
From rating taske:
Q = 1280 cfs
h = 3.75 ft
elev = 5721 ft



② Colo R @ Detsero

Q = 1280 cfs (9-24-52 date of photo)
h = 2.6 ft and w = 95 ft scaled from photo
elev = 6130 ft

Profile



$$h_e + \frac{V_1^2}{2g} + 3.75 = \frac{V_2^2}{2g} + 2.6 + 409$$

$$V_2 = \frac{Q}{A} = \frac{1280}{87\%\,(95)(2.6)} = 5.92 \text{ fps}$$

$$\frac{V_2^2}{2g} = \frac{5.92^2}{64.4} = 0.54$$

$$h_e + \frac{V_1^2}{2g} = 0.54 + 2.6 + 409 - 3.75 = 408.39 \qquad (1)$$

$$h_e = S_e \times L \qquad (2)$$

$$S_e = \left(\frac{V_1 n}{1.486 R^{2/3}}\right)^2 = \frac{V_1^2 (0.013)^2}{1.486^2 R^{4/3}} = \frac{V_1^2 (.000169)}{2.21} = .0000765 V_1^2$$

40<

GPO 839 - 170

FWPCA

COMPUTATION SHEET

PROJECT SCP SHEET NO. 13 OF

SUBJECT Time for water to travel BY PS DATE

OFFICE between Dotsero and Glenwood CHECKED BY DATE

substitute into (2)

$$h_2 = (0.0000765\, V_1^2)(14\text{ mi})(5280\text{ ft/mi})$$
$$= 5.65\, V_1^2$$

substitute into (1)

$$5.65\, V_1^2 + 0.16\, V_1^2 = 408.39$$
$$V_1^2 = \frac{408}{5.81} = 70.2$$
$$V_1 = 8.40 \text{ fps}$$

∴ Average velocity of 1280 cfs is $\frac{8.40 + 5.92}{2} = 7.16$ fps

Time required for particle of water to travel between stations is

$$\frac{1.4 \times 5.28 \times 10^4}{7.16} = 10300 \text{ sec} = 2.86 \text{ hrs}$$

GPO 839 • 170

Data - Calo R near Dotsero, Colo.

APPENDIX B

9-705. Colorado River near Dotsero, Colo.

Location.--Lat 39°38'40", long 107°04'40", in sec.6, T.5 S., R.86 W., on left bank about 500 ft south of U. S. Highways 6 and 24, 1½ miles west of Dotsero, and 1½ miles downstream from Eagle River.

Drainage area.--4,390 sq mi, approximately.

Gage.--Water-stage recorder. Altitude of gage is 6,130 ft (from topographic map).

Records available.--October 1940 to September 1965.

Average discharge.--25 years, 2,130 cfs (1,542,000 acre-ft per year).

Extremes.--Maximum discharge during year, 11,400 cfs June 18 (gage height, 8.77 ft); minimum daily, 350 cfs Dec. 8.
1940-65: Maximum discharge, 19,100 cfs June 8, 1952 (gage height, 11.36 ft); minimum daily, 330 cfs Jan. 5, 1944.

Remarks.--Records good except those for periods of ice effect or no gage-height record, which are fair. Natural flow of stream affected by transmountain diversions, storage reservoirs, power development, diversions for irrigation of 48,000 acres above station, and return flow from irrigated areas.

Cooperation.--Gage-height record collected in cooperation with The Public Service Co. of Colorado.

Rating table, except periods of ice effect (gage height, in feet, and discharge, in cubic feet per second)

1.7	660	5.0	4,250
1.9	760	6.0	5,800
2.0	820	7.0	7,550
2.5	1,200	8.0	9,650
3.0	1,660	9.0	12,100
4.0	2,870		

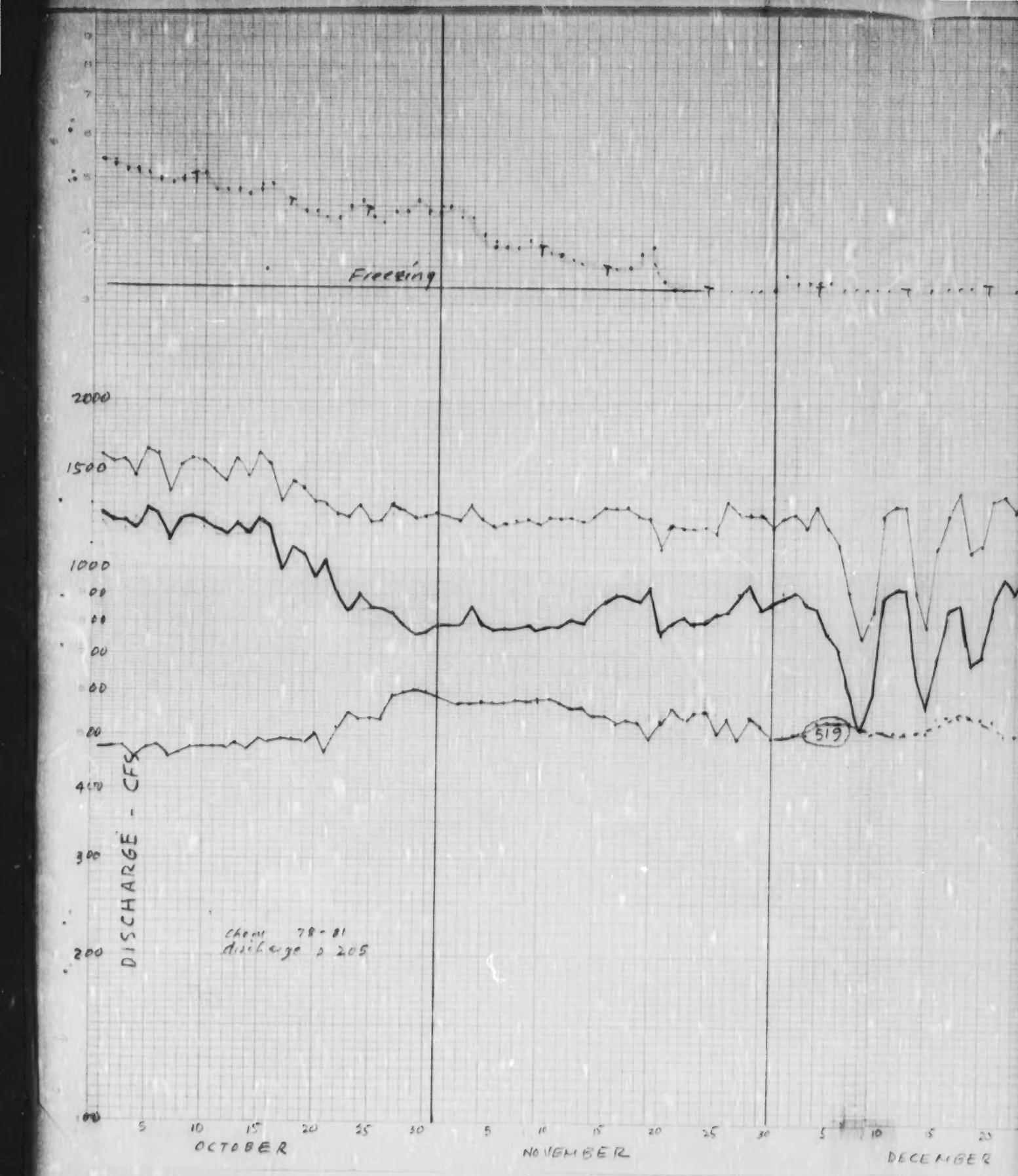
Discharge, in cubic feet per second, water year October 1964 to September 1965

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	1,210	784	869	660	700	735	1,220	2,730	4,560	4,490	3,400	1,660
2	1,160	784	876	740	660	* 710	1,220	3,560	4,780	4,600	4,670	1,610
3	1,170	784	834	700	720	675	1,250	4,120	4,800	4,680	4,250	1,560
4	1,230	790	802	660	780	685	1,220	* 4,280	5,000	4,440	4,150	1,600
5	1,180	778	750	740	* 700	725	1,190	4,250	4,840	4,260	3,860	1,730
6	* 1,160	766	710	780	778	715	1,140	4,040	4,670	4,180	3,270	1,850
7	1,140	760	b600	860	784	705	1,140	3,620	4,880	4,050	3,030	1,690
8	1,150	760	b550	920	755	705	1,230	3,300	5,500	3,900	2,780	1,640
9	1,180	772	b650	820	735	705	1,430	3,030	6,090	3,960	* 2,660	1,590
10	1,160	766	b800	800	740	735	1,550	2,730	* 6,810	3,730	2,520	1,480
11	1,140	* 784	b900	800	740	745	1,530	2,610	7,530	3,730	2,380	1,410
12	1,150	778	b800	800	695	745	1,430	2,570	7,810	4,000	2,220	1,370
13	1,150	796	b700	800	b 560	745	1,770	2,840	8,250	* 4,380	2,050	1,340
14	1,180	827	b600	780	b 620	755	1,780	3,160	9,280	4,420	2,100	1,280
15	1,180	862	700	780	b 720	755	* 1,740	3,140	9,520	4,300	2,070	1,240
16	1,030	855	800	740	784	755	1,870	2,880	9,630	3,790	1,970	1,200
17	1,080	855	780	700	802	772	2,050	3,010	10,400	3,410	1,920	1,180
18	1,030	883	720	660	805	720	1,670	3,760	10,900	3,720	2,030	1,270
19	976	876	700	660	778	680	1,340	4,110	10,500	4,260	2,700	1,450
20	976	778	780	660	766	705	1,430	* 4,680	9,820	4,120	3,190	1,560
21	904	790	880	700	725	740	1,890	5,400	8,970	4,100	3,370	1,660
22	827	802	900	740	750	766	2,400	6,170	7,950	3,830	2,860	1,610
23	827	808	940	660	745	772	2,600	6,990	7,280	4,190	2,620	1,560
24	834	796	1,000	720	705	766	2,690	7,140	* 6,780	4,480	2,700	1,580
25	834	841	1,000	800	735	745	2,560	6,700	6,560	4,720	2,440	1,610
26	814	911	900	780	730	745	2,330	6,000	6,330	4,940	2,210	1,610
27	778	900	900	700	725	760	2,090	5,160	5,950	4,520	2,120	1,620
28	750	820	900	680	745	796	1,750	4,210	5,560	4,260	2,040	1,580
29	750	840	820	680	-	* 820	1,720	3,800	5,500	4,080	1,740	1,720
30	760	* 860	700	720	----------	911	2,070	3,750	5,190	3,930	1,720	1,800
31	760	----------	600	800	----------	1,100	----------	4,080	----------	4,420	* 1,740	----------
Total	31,470	24,406	24,461	23,040	20,479	23,393	51,300	137,820	211,640	129,890	84,780	46,060
Mean	1,015	814	789	743	731	755	1,710	4,123	7,055	4,190	2,735	1,535
Ac-ft	62,420	48,410	48,520	45,700	40,620	46,400	101,800	253,300	419,800	257,600	168,200	91,360

Calendar year 1964: Max 6,040 Min 440 Mean 1,337 Ac-ft 970,800
Water year 1964-65: Max 10,900 Min 330 Mean 2,188 Ac-ft 1,584,000

* Discharge measurement made on this day.
b Stage-discharge relation affected by ice.
Note.--No gage-height record Nov. 27-30, Dec. 13 to Feb. 5 (stage-discharge relation affected by ice during part of period).

Data - Calo R ar Glenwood Springs, Colo


Freezing
2000
1500
1000
519
DISCHARGE - CFS
Chem 78-81
discharge 205
OCTOBER
NOVEMBER
DECEMBER

COLO R
WATE
P 205
P 78
SALT LOAD
(T/DAT
DISCHARGE
(CFS
2000
1000
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4
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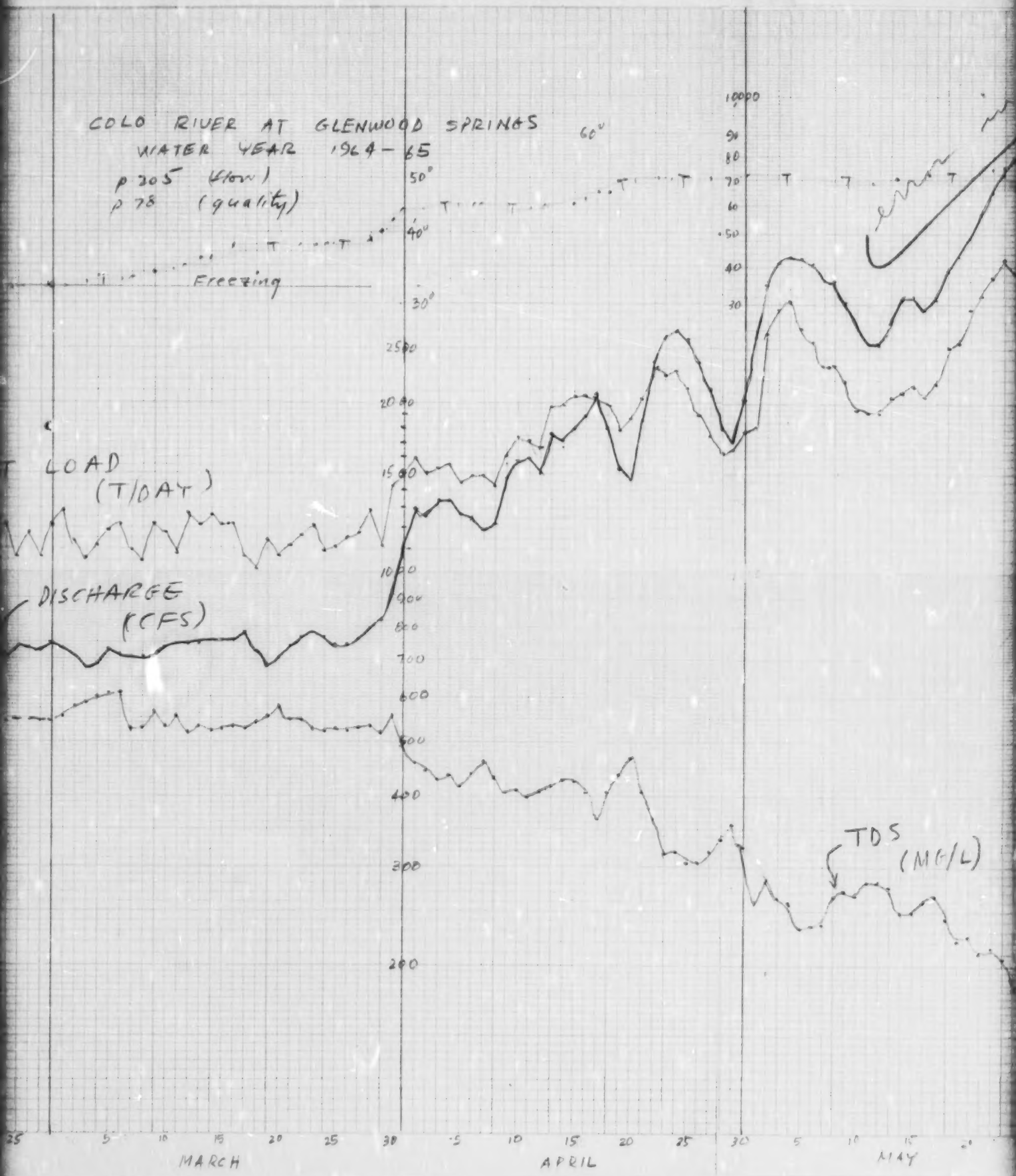
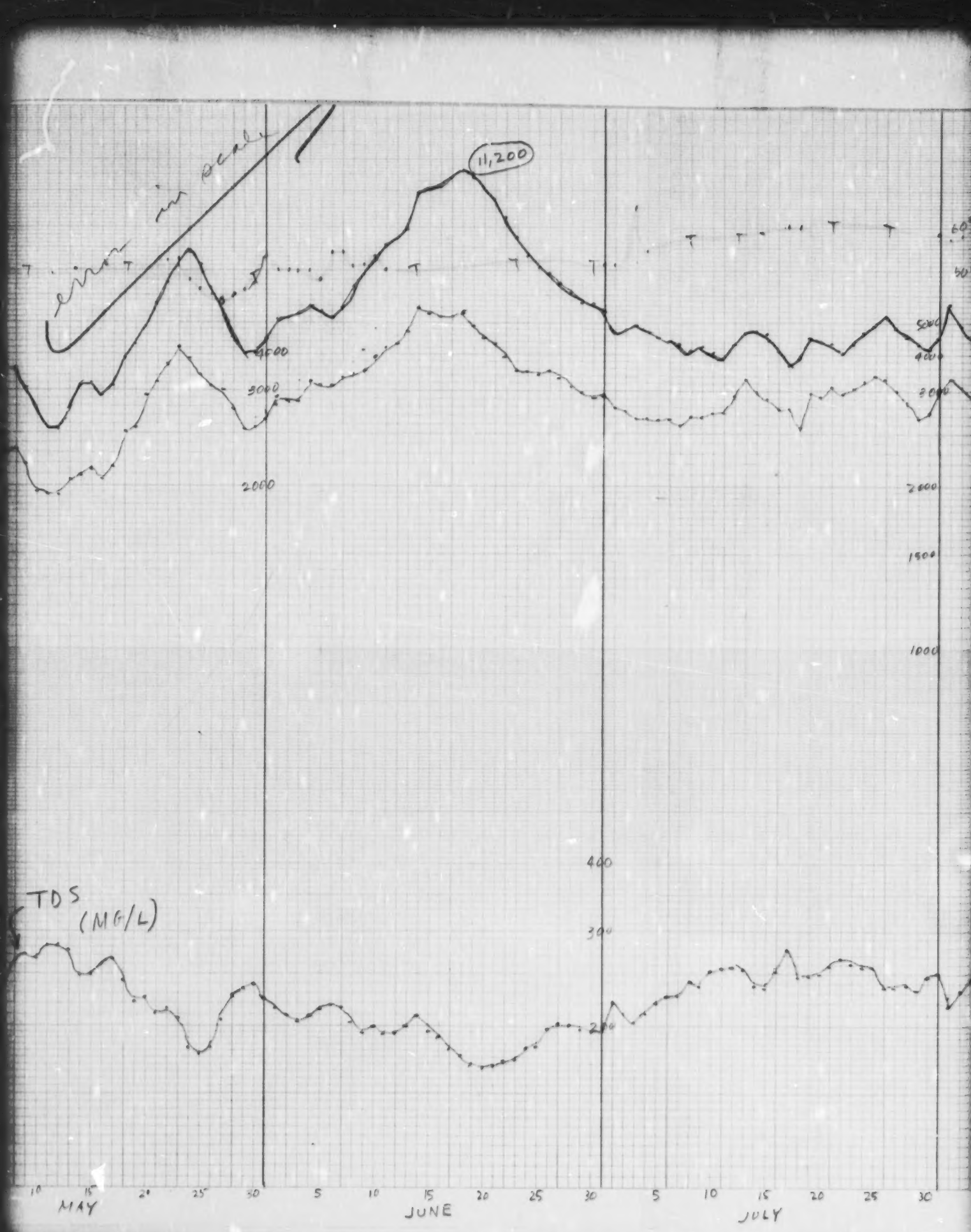

COLO RIVER AT GLENWOOD SPRINGS
WATER YEAR 1964-65
p 205 (flow)
p 78 (quality)
Freezing
T LOAD (T/DAY)
DISCHARGE (CFS)
TDS (MG/L)
MARCH
APRIL
MAY


river in peak
11,200
4000
3000
2000
5000
4000
3000
2000
1500
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400
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200
TDS
(MG/L)
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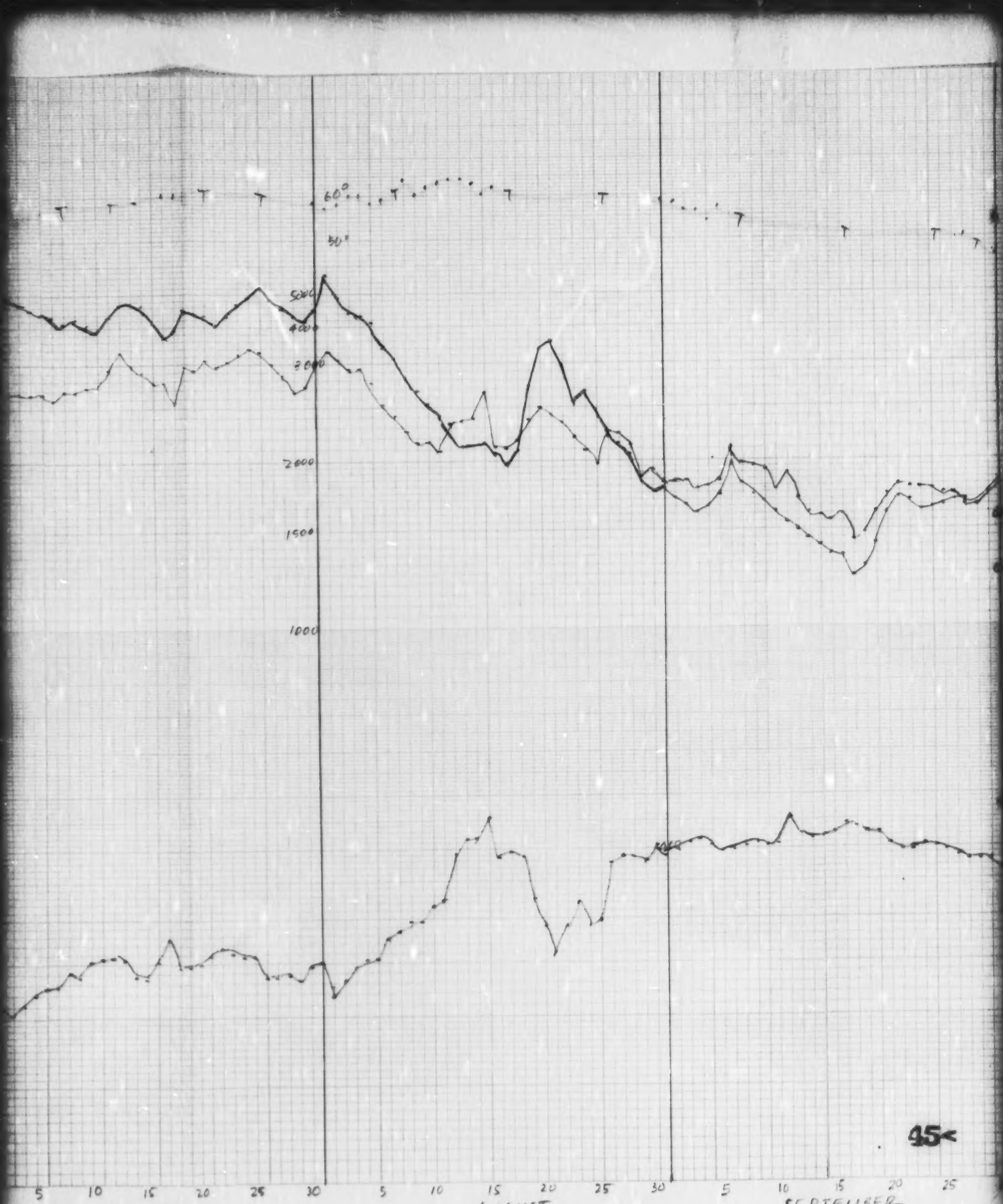
MAY
JUNE
JULY


60°
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JULY
AUGUST
SEPTEMBER

9-725. Colorado River at Glenwood Springs, Colo.

Location.--Lat 39°33'00", long 107°19'20", in sec.9, T.6 S., R.89 W., on right bank at powerplant at Glenwood Springs, 10 ft from U. S. Highways 6 and 24 and half a mile upstream from Roaring Fork River.

Drainage area.--4,560 sq mi, approximately.

Records available.--May 1899 to September 1965. Prior to October 1918, published as Grand River at Glenwood Springs.

Gage.--Water-stage recorder (digital). Datum of gage is 5,720.71 ft above mean sea level, adjustment of 1912. Prior to Jan. 1, 1900, wire-weight gage at railroad bridge 2,500 ft downstream at different datum. Jan. 1, 1900, to May 16, 1910, staff or float gage at present site and datum.

Average discharge.--66 years, 2,717 cfs (1,967,000 acre-ft per year).

Extremes.--Maximum discharge during year, 11,900 cfs June 18 (gage height, 8.83 ft); minimum daily, 519 cfs Dec. 8.
1899-1965: Maximum discharge, 30,100 cfs June 14, 1918 (gage height, 12.55 ft); minimum daily, 286 cfs Jan. 22, 1935.

Remarks.--Records good. Natural flow of stream affected by transmountain diversions, storage reservoirs, power development, diversions for irrigation of about 70,000 acres, and return flow from irrigated areas. Low flow regulated by Shoshone powerplant 6 miles above station. Records of chemical analyses and water temperatures for the water year 1965 are published in Part 2 of this report as "near Glenwood Springs."

Rating table (gage height, in feet, and discharge, in cubic feet per second)

2.7	490	5.0	2,910
3.0	650	6.0	4,800
3.5	1,020	7.0	7,160
4.0	1,520	9.0	12,600

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1964 TO SEPTEMBER 1965

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1	1,250	794	919	758	* 919	*865	1,290	2,620	5,060	4,720	3,620	1,710
2	1,220	* 796	914	804	702	727	1,260	3,500	5,140	4,760	4,910	1,670
3	1,220	859	873	717	819	671	1,330	4,140	5,280	4,900	4,400	1,610
4	1,190	793	851	* 758	884	687	1,330	* 4,350	5,550	4,720	4,310	1,650
5	1,280	779	774	868	782	711	1,270	4,320	5,360	4,490	4,090	1,730
6	1,240	785	726	871	873	728	1,250	4,070	5,210	4,380	3,870	1,760
7	*1,120	783	599	977	843	773	1,190	3,650	5,480	4,260	3,120	1,810
8	1,220	793	819	1,010	868	737	1,210	3,300	6,260	4,140	2,820	1,730
9	1,230	781	605	890	802	802	1,470	3,020	6,810	4,230	* 2,690	1,680
10	1,220	790	893	842	819	822	1,580	2,720	7,350	4,010	2,520	1,610
11	1,180	797	933	876	789	719	1,590	2,550	*8,120	3,980	2,400	1,540
12	1,150	810	929	897	621	839	1,500	2,520	8,390	4,230	2,220	1,490
13	1,200	801	649	881	614	789	1,560	2,780	8,860	* 4,640	2,110	1,440
14	1,160	846	565	884	706	822	1,720	3,120	9,920	4,680	2,110	1,400
15	1,220	879	693	896	875	861	1,800	3,160	10,100	4,820	2,160	1,350
16	1,180	902	848	862	768	859	1,890	2,920	10,200	4,110	2,040	1,340
17	1,000	898	866	829	729	749	2,070	3,060	10,800	3,640	1,990	1,330
18	1,090	877	678	790	809	698	1,800	3,860	11,200	3,850	2,090	1,280
19	1,060	931	706	758	720	767	* 1,520	* 4,300	10,800	4,460	2,720	1,410
20	970	760	858	729	797	689	1,460	4,870	10,100	4,350	3,190	1,600
21	1,030	801	977	824	793	749	1,850	5,680	9,480	4,330	3,440	1,700
22	901	816	923	824	691	787	2,360	6,490	*8,500	4,010	2,990	1,680
23	841	798	988	729	774	856	2,600	7,580	7,660	4,330	2,550	1,620
24	901	804	1,110	790	823	776	2,660	7,880	7,130	4,660	2,670	1,650
25	851	839	1,110	908	721	777	2,590	7,240	6,910	4,930	2,470	1,640
26	849	914	934	785	798	820	2,330	6,320	6,530	5,200	2,200	1,680
27	829	944	946	708	727	826	2,100	5,440	6,150	4,760	2,130	1,670
28	792	855	978	848	834	906	1,800	4,510	5,720	4,400	2,050	1,650
29	766	875	906	786	-------	* 796	1,710	4,030	5,650	4,270	1,820	1,730
30	770	* 888	835	898	-------	949	2,020	4,000	5,360	4,100	1,760	1,840
31	788	-------	575	919	-------	1,140	-------	4,440	-------	4,540	* 1,770	-------
TOTAL	32,718	24,982	25,480	25,946	22,040	24,691	52,310	132,440	225,080	136,780	86,730	48,080
MEAN	1,055	833	822	837	787	796	1,744	4,272	7,503	4,412	2,798	1,603
AC-FT	64,900	49,550	50,540	51,460	43,720	48,970	103,800	262,700	446,400	271,300	172,000	95,370

CALENDAR YEAR	1964	MAX	6,610	MIN	432	MEAN	1,407	AC-FT	1,021M
WATER YEAR	1964-65	MAX	11,200	MIN	519	MEAN	2,294	AC-FT	1,661M

* Discharge measurement made on this day.

46<

9-7111. COLORADO RIVER NEAR GLENWOOD SPRINGS, COLO.--Continued

Specific conductance (micromhos at 25°C), water year October 1964 to September 1965

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	736	809	786	1120	901	862	715	398	332	343	338	620
2	737	891	794	1020	--	901	689	444	324	335	360	638
3	742	891	764	941	826	909	668	409	314	315	383	642
4	708	901	886	941	--	936	676	403	324	327	393	--
5	736	898	886	--	866	960	649	362	332	341	391	616
6	716	896	11	941	850	--	684	366	338	351	432	--
7	710	905	816	922	835	--	716	368	335	352	--	625
8	723	902	848	861	--	816	672	410	314	376	464	634
9	741	893	810	--	--	876	631	420	303	367	461	629
10	740	911	810	864	--	826	633	414	309	392	495	633
11	739	896	810	--	--	865	620	435	300	394	503	709
12	726	911	810	864	946	808	638	438	302	400	607	660
13	751	886	810	806	930	825	--	427	309	394	642	646
14	733	854	810	--	914	811	666	387	325	368	654	654
15	760	854	722	806	--	817	661	389	302	362	709	665
16	753	823	810	612	--	827	624	406	297	391	602	687
17	780	835	810	818	--	822	569	412	280	432	613	675
18	764	826	922	--	--	842	634	376	273	384	602	668
19	762	774	943	--	--	865	675	343	--	--	506	663
20	783	833	904	--	--	898	725	348	259	388	453	629
21	730	878	806	--	869	851	634	328	260	402	404	613
22	804	844	806	--	--	848	564	332	266	417	--	611
23	854	859	806	--	--	817	495	320	266	404	499	632
24	834	862	804	829	857	808	--	283	282	399	452	624
25	824	796	802	--	--	821	--	275	284	--	462	615
26	838	844	840	--	--	811	471	283	308	--	590	--
27	915	777	802	--	846	819	482	319	313	364	605	589
28	933	848	802	--	--	826	523	355	310	369	--	592
29	939	829	1001	--	--	809	557	--	305	361	592	591
30	936	772	1160	--	--	868	509	370	303	384	632	566
31	921	--	1100	809	--	756	--	346	--	390	598	--
Average	730	833	--	--	--	844	621	373	302	375	515	634

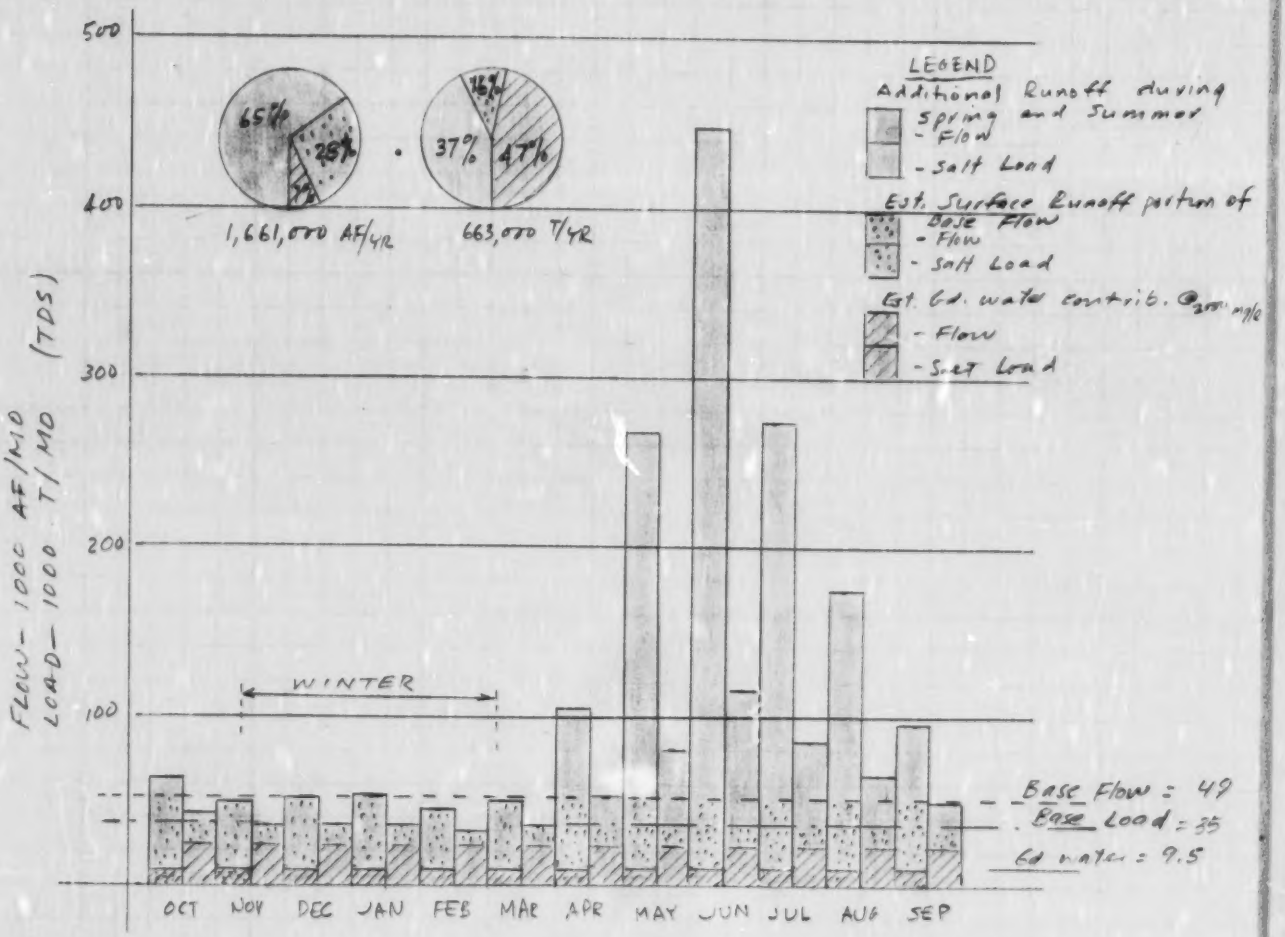
FWPCA

COMPUTATION SHEET

PROJECT _____ SHEET NO. _____ OF _____

SUBJECT COLO R @ GLENWOOD SPRINGS BY RS DATE 12/17/69

OFFICE WY 1964-65 CHECKED BY _____ DATE _____



Base Flow = 49,000 x 12 = 588,000 AF (35%)

Runoff = 1,661,000 − 588,000 = 1,073,000 AF (65%)

Base Load = 35,000 x 12 = 420,000 T (63%)

Runoff = 663,000 − 420,000 = 243,000 T (37%)

Quality base flow = 420/568 = 0.715 taf = 525 mg/L

Quality runoff = 343/1073 = 0.226 taf = 166 mg/L

48<

GPO 839 - 170

FLOW AND QUALITY DATA

COLORADO RIVER AT GLENWOOD SPRINGS

WATER YEAR 1964-65

TDS vs EC not as close as could be

OCTOBER

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	1250.	736.	472.	1590.
2	1220.	737.	472.	1554.
3	1220.	742.	476.	1564.
4	1190.	708.	454.	1456.
5	1280.	736.	472.	1628.
6	1240.	746.	478.	1598.
7	1120.	710.	455.	1374.
8	1220.	723.	463.	1524.
9	1230.	741.	475.	1575.
10	1220.	740.	474.	1560.
11	1180.	739.	474.	1507.
12	1150.	726.	465.	1443.
13	1200.	751.	481.	1557.
14	1160.	733.	470.	1469.
15	1220.	760.	487.	1602.
16	1180.	753.	483.	1535.
17	1000.	766.	491.	1324.
18	1090.	764.	490.	1439.
19	1060.	762.	488.	1396.
20	970.	783.	502.	1312.
21	1030.	730.	468.	1299.
22	901.	804.	515.	1252.
23	841.	854.	547.	1241.
24	901.	834.	535.	1298.
25	851.	834.	535.	1226.
26	849.	834.	535.	1224.
27	829.	915.	587.	1311.
28	792.	933.	598.	1277.
29	766.	939.	602.	1243.
30	770.	936.	600.	1245.
31	788.	921.	590.	1254.
	32718.			43878.

50<

NOVEMBER

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	794.	309.	198.	424.
2	796.	891.	571.	1226.
3	853.	891.	571.	1313.
4	793.	901.	578.	1235.
5	779.	898.	576.	1209.
6	785.	896.	574.	1215.
7	783.	906.	581.	1226.
8	793.	902.	578.	1236.
9	781.	898.	576.	1212.
10	790.	911.	584.	1244.
11	797.	896.	574.	1234.
12	810.	881.	565.	1233.
13	801.	886.	568.	1226.
14	846.	854.	547.	1248.
15	879.	854.	547.	1297.
16	902.	823.	528.	1283.
17	898.	835.	535.	1296.
18	877.	825.	529.	1250.
19	931.	774.	496.	1245.
20	760.	833.	534.	1094.
21	801.	878.	563.	1215.
22	816.	844.	541.	1190.
23	798.	859.	551.	1185.
24	804.	862.	553.	1198.
25	839.	796.	510.	1154.
26	914.	844.	541.	1333.
27	944.	777.	498.	1267.
28	855.	848.	544.	1253.
29	875.	829.	531.	1253.
30	888.	779.	499.	1195.
	24982.			36190.

DECEMBER

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	919.	786.	504.	1248.
2	914.	794.	509.	1254.
3	873.	794.	509.	1198.
4	851.	886.	568.	1303.
5	774.	886.	568.	1185.
6	726.	886.	568.	1112.
7	599.	886.	568.	917.
8	519.	848.	544.	761.
9	605.	810.	519.	847.
10	893.	810.	519.	1250.
11	933.	810.	519.	1306.
12	929.	810.	519.	1300.
13	649.	810.	519.	908.
14	565.	810.	519.	791.
15	693.	922.	591.	1104.
16	848.	922.	591.	1351.
17	866.	922.	591.	1380.
18	678.	922.	591.	1080.
19	706.	913.	585.	1114.
20	858.	904.	579.	1340.
21	977.	806.	517.	1361.
22	923.	806.	517.	1286.
23	988.	806.	517.	1376.
24	1110.	804.	515.	1542.
25	1110.	802.	514.	1538.
26	934.	802.	514.	1294.
27	946.	802.	514.	1311.
28	978.	1001.	642.	1692.
29	906.	1100.	705.	1722.
30	636.	1100.	705.	1209.
31	575.	1100.	705.	1093.
	25481.			38172.

52<

JANUARY

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	758.	1100.	705.	1441.
2	804.	1020.	654.	1417.
3	717.	941.	603.	1166.
4	758.	941.	603.	1233.
5	868.	941.	603.	1411.
6	871.	941.	603.	1416.
7	977.	902.	578.	1523.
8	1010.	864.	554.	1508.
9	890.	864.	554.	1329.
10	882.	864.	554.	1317.
11	876.	864.	554.	1308.
12	887.	864.	554.	1324.
13	881.	806.	517.	1227.
14	884.	806.	517.	1231.
15	896.	806.	517.	1248.
16	862.	812.	520.	1210.
17	829.	818.	524.	1172.
18	790.	818.	524.	1117.
19	758.	818.	524.	1071.
20	729.	818.	524.	1030.
21	824.	829.	531.	1180.
22	824.	829.	531.	1180.
23	729.	829.	531.	1044.
24	790.	829.	531.	1132.
25	908.	829.	531.	1301.
26	785.	829.	531.	1125.
27	708.	829.	531.	1014.
28	848.	809.	519.	1185.
29	786.	809.	519.	1099.
30	898.	809.	519.	1255.
31	919.	809.	519.	1285.
	25946.			38499.

FEBRUARY

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	919.	809.	519.	1285.
2	702.	809.	519.	981.
3	819.	866.	555.	1226.
4	884.	866.	555.	1323.
5	782.	866.	555.	1170.
6	873.	850.	545.	1282.
7	843.	835.	535.	1216.
8	868.	835.	535.	1252.
9	802.	835.	535.	1157.
10	819.	946.	606.	1339.
11	789.	946.	606.	1290.
12	621.	946.	606.	1015.
13	614.	930.	596.	987.
14	706.	914.	586.	1115.
15	875.	914.	586.	1382.
16	768.	914.	586.	1213.
17	729.	914.	586.	1151.
18	809.	869.	557.	1215.
19	720.	869.	557.	1081.
20	797.	869.	557.	1197.
21	793.	869.	557.	1191.
22	831.	869.	557.	1248.
23	774.	869.	557.	1162.
24	823.	857.	549.	1219.
25	721.	846.	542.	1054.
26	798.	846.	542.	1167.
27	727.	846.	542.	1063.
28	834.	846.	542.	1219.
	22040.			33200.

MARCH

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	865.	862.	553.	1288.
2	727.	901.	578.	1132.
3	671.	909.	583.	1054.
4	687.	936.	600.	1111.
5	711.	960.	615.	1179.
6	728.	960.	615.	1208.
7	773.	816.	523.	1090.
8	737.	816.	523.	1039.
9	802.	876.	562.	1214.
10	822.	826.	529.	1173.
11	719.	865.	554.	1075.
12	839.	808.	518.	1171.
13	783.	825.	529.	1116.
14	822.	811.	520.	1152.
15	861.	817.	524.	1216.
16	859.	827.	530.	1228.
17	749.	822.	527.	1064.
18	696.	842.	540.	1013.
19	767.	865.	554.	1146.
20	689.	898.	576.	1069.
21	749.	851.	545.	1101.
22	787.	848.	544.	1153.
23	856.	817.	524.	1208.
24	776.	808.	518.	1083.
25	777.	821.	526.	1102.
26	820.	811.	520.	1149.
27	826.	819.	525.	1169.
28	906.	826.	529.	1293.
29	796.	809.	519.	1113.
30	949.	868.	556.	1423.
31	1140.	756.	485.	1489.
	24689.			36024.

APRIL

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	1290.	715.	458.	1594.
2	1260.	689.	442.	1500.
3	1330.	668.	428.	1535.
4	1330.	676.	433.	1554.
5	1270.	649.	416.	1424.
6	1250.	684.	438.	1477.
7	1190.	716.	459.	1472.
8	1210.	672.	431.	1405.
9	1470.	631.	404.	1603.
10	1580.	633.	406.	1728.
11	1590.	620.	397.	1703.
12	1500.	638.	409.	1654.
13	1760.	650.	417.	1977.
14	1720.	666.	427.	1979.
15	1800.	661.	424.	2056.
16	1890.	634.	406.	2071.
17	2070.	569.	365.	2035.
18	1800.	634.	406.	1972.
19	1520.	675.	433.	1773.
20	1460.	725.	465.	1829.
21	1850.	634.	406.	2027.
22	2360.	564.	362.	2300.
23	2600.	495.	317.	2224.
24	2660.	495.	317.	2275.
25	2590.	471.	302.	2108.
26	2330.	471.	302.	1896.
27	2100.	482.	309.	1749.
28	1800.	523.	335.	1627.
29	1710.	557.	357.	1646.
30	2020.	509.	326.	1777.
	52310.			53971.

MAY

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	2620.	398.	255.	1802.
2	3500.	444.	285.	2685.
3	4140.	409.	262.	2926.
4	4350.	403.	258.	3029.
5	4320.	362.	232.	2702.
6	4070.	366.	235.	2574.
7	3650.	368.	236.	2321.
8	3300.	410.	263.	2338.
9	3020.	420.	269.	2192.
10	2720.	414.	265.	1946.
11	2550.	435.	279.	1917.
12	2520.	438.	281.	1907.
13	2780.	427.	274.	2051.
14	3120.	387.	248.	2086.
15	3160.	389.	249.	2124.
16	2920.	406.	260.	2049.
17	3060.	412.	264.	2179.
18	3860.	376.	241.	2508.
19	4300.	343.	220.	2549.
20	4870.	348.	223.	2929.
21	5680.	328.	210.	3219.
22	6490.	332.	213.	3723.
23	7580.	320.	205.	4191.
24	7880.	283.	181.	3854.
25	7240.	275.	176.	3440.
26	6320.	283.	181.	3091.
27	5440.	319.	204.	2999.
28	4510.	355.	228.	2767.
29	4030.	362.	232.	2521.
30	4000.	370.	237.	2557.
31	4440.	346.	222.	2655.
	132440.			81830.

57<

JUNE

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	5060.	332.	213.	2903.
2	5140.	324.	208.	2878.
3	5280.	314.	201.	2865.
4	5550.	324.	208.	3107.
5	5360.	332.	213.	3075.
6	5210.	338.	217.	3043.
7	5480.	335.	215.	3172.
8	6260.	314.	201.	3397.
9	6810.	303.	194.	3566.
10	7350.	309.	198.	3925.
11	8120.	300.	192.	4209.
12	8390.	302.	194.	4378.
13	8860.	309.	198.	4731.
14	9920.	325.	208.	5571.
15	10100.	302.	194.	5271.
16	10200.	297.	190.	5235.
17	10800.	280.	179.	5225.
18	11200.	273.	175.	5284.
19	10800.	263.	169.	4908.
20	10100.	259.	166.	4520.
21	9480.	260.	167.	4259.
22	8500.	266.	171.	3907.
23	7660.	266.	171.	3521.
24	7130.	282.	181.	3474.
25	6910.	284.	182.	3391.
26	6530.	308.	197.	3475.
27	6150.	313.	201.	3326.
28	5720.	310.	199.	3064.
29	5650.	305.	196.	2978.
30	5360.	303.	194.	2806.
	225080.			115465.

JULY

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	4720.	343.	220.	2798.
2	4760.	335.	215.	2755.
3	4900.	315.	202.	2667.
4	4720.	327.	210.	2667.
5	4490.	341.	219.	2646.
6	4380.	351.	225.	2657.
7	4260.	352.	226.	2591.
8	4140.	376.	241.	2690.
9	4230.	367.	235.	2683.
10	4010.	392.	251.	2716.
11	3980.	394.	253.	2710.
12	4230.	400.	256.	2924.
13	4640.	394.	253.	3159.
14	4680.	368.	236.	2976.
15	4620.	362.	232.	2890.
16	4110.	391.	251.	2777.
17	3640.	432.	277.	2717.
18	3850.	384.	246.	2555.
19	4460.	386.	247.	2975.
20	4350.	388.	249.	2917.
21	4330.	402.	258.	3008.
22	4010.	417.	267.	2890.
23	4330.	404.	259.	3023.
24	4680.	399.	256.	3227.
25	4930.	399.	256.	3399.
26	5200.	364.	233.	3271.
27	4760.	364.	233.	2994.
28	4460.	369.	237.	2844.
29	4270.	361.	231.	2664.
30	4100.	384.	246.	2721.
31	4540.	390.	250.	3060.
	136780.			88566.

AUGUST

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	5620.	338.	217.	3282.
2	4910.	360.	231.	3054.
3	4400.	383.	246.	2912.
4	4310.	393.	252.	2927.
5	4090.	391.	251.	2763.
6	3370.	432.	277.	2516.
7	3120.	445.	285.	2399.
8	2820.	464.	297.	2261.
9	2690.	461.	296.	2143.
10	2520.	495.	317.	2156.
11	2400.	503.	322.	2086.
12	2220.	607.	389.	2329.
13	2110.	642.	412.	2341.
14	2110.	654.	419.	2385.
15	2160.	709.	454.	2646.
16	2040.	602.	386.	2122.
17	1990.	613.	393.	2108.
18	2090.	602.	386.	2174.
19	2720.	506.	324.	2378.
20	3190.	453.	290.	2497.
21	3440.	404.	259.	2402.
22	2990.	451.	289.	2330.
23	2550.	499.	320.	2199.
24	2670.	452.	290.	2085.
25	2470.	462.	296.	1972.
26	2200.	590.	378.	2243.
27	2130.	605.	388.	2227.
28	2050.	600.	385.	2125.
29	1820.	592.	379.	1862.
30	1760.	632.	405.	1922.
31	1770.	598.	383.	1829.
	86730.			72675.

60<

SEPTEMBER

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	1710.	620.	397.	1832.
2	1670.	638.	409.	1841.
3	1610.	642.	412.	1786.
4	1650.	630.	404.	1796.
5	1730.	616.	395.	1841.
6	1960.	620.	397.	2100.
7	1810.	625.	401.	1955.
8	1730.	634.	406.	1895.
9	1680.	629.	403.	1826.
10	1610.	633.	406.	1761.
11	1540.	709.	454.	1887.
12	1490.	660.	423.	1699.
13	1440.	646.	414.	1607.
14	1400.	656.	420.	1587.
15	1350.	665.	426.	1551.
16	1340.	687.	440.	1591.
17	1230.	675.	433.	1435.
18	1280.	668.	428.	1478.
19	1410.	663.	425.	1615.
20	1600.	629.	403.	1739.
21	1700.	613.	393.	1801.
22	1680.	611.	392.	1774.
23	1620.	632.	405.	1769.
24	1630.	624.	400.	1758.
25	1640.	615.	394.	1743.
26	1680.	600.	385.	1742.
27	1670.	589.	378.	1700.
28	1650.	592.	379.	1688.
29	1730.	591.	379.	1767.
30	1840.	566.	363.	1800.
	48080.			52363.

SUMMARY

MONTH	DISCHARGE AF/YR	SALT LOAD T/YR
OCT	59055.	43878.
NOV	45091.	36190.
DEC	45992.	38172.
JAN	46831.	38499.
FEB	39781.	33200.
MAR	44563.	36024.
APR	94417.	53971.
MAY	239049.	81830.
JUN	406260.	115465.
JUL	246882.	88566.
AUG	156544.	72675.
SEP	86782.	52363.
	1511247.	690833.
	1,611,000	663,000

Progress Report #4

Data - Lab. R above Eagle River

APPENDIX D

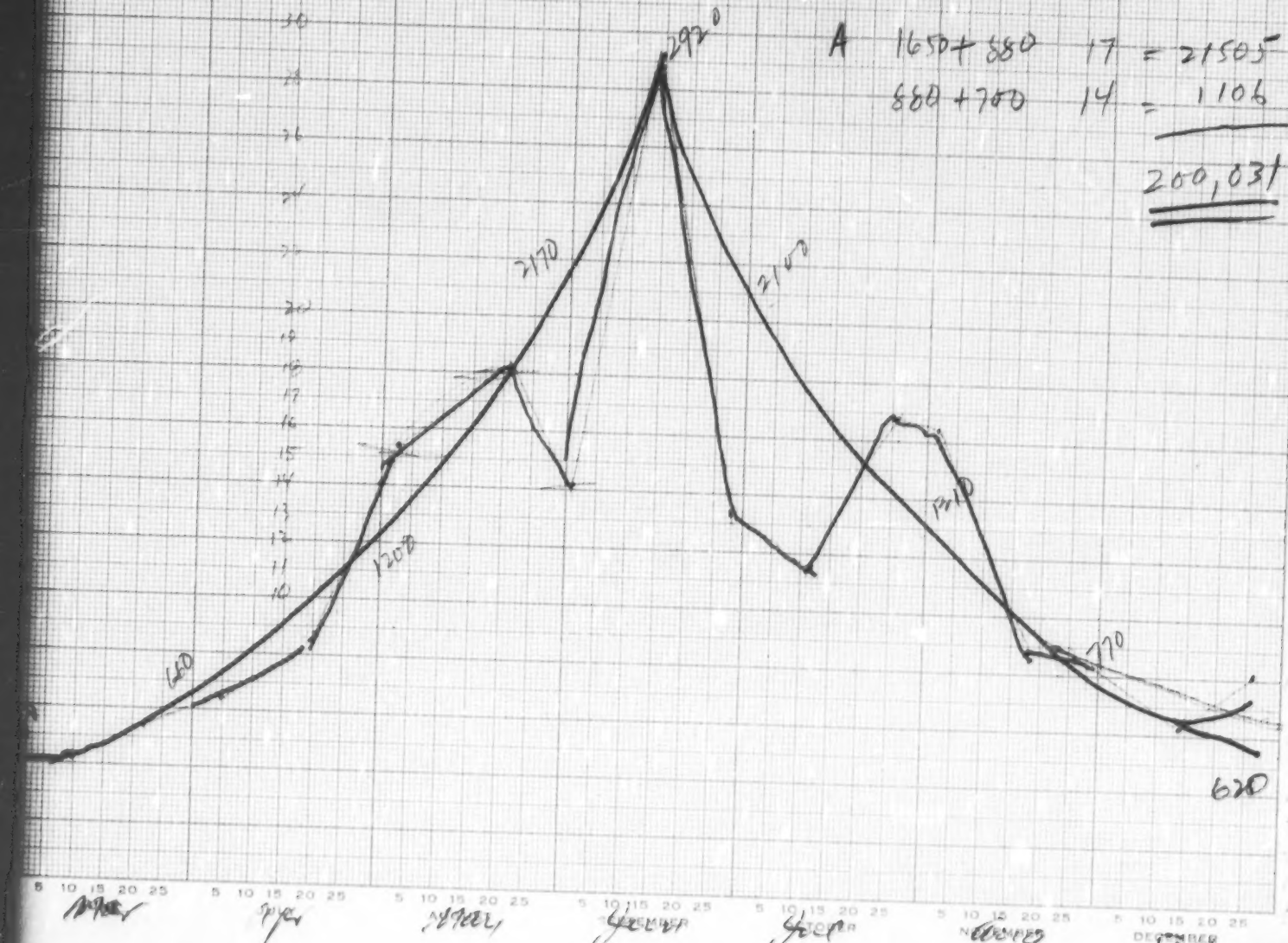
COLO R ABOVE EAGLE R
(Data from Field station)

Oct	31 x 550	= 17,050
N	30 x 465	= 13,950
D	31 x 425	= 13,175
J	31 x 400	= 12,400
F	28 x 400	= 11,200
M	10 x 400	= 4000
	21 x 530	= 11,130
A	30 x 930	= 27,900
M	31 x 1685	= 52,235
J	14 x 2545	= 35,630
	16 x 2510	= 40,160
J	31 x 1705	= 52,855
A	31 x 1140	= 32,240
S	30 x 695	= 20,850
		344,775

241,020

344,775
-241,020
+200,031
303,800

A	(610 + 650)	5	=	3150
	(650 + 850)	15	=	11250
	(650 + 1400)	10	=	11250
M	1400 + 1540	3	=	4410
	1540 + 1830	19	=	32915
	1830 + 1420	9	=	14625
J	1400 + 2920	13	=	22230
	2920 + 1340	17	=	36210
J	1340 + 1150	7	=	8715
	1150 + 1680	19	=	26885
	1680 + 1660	4	=	6680
A	1650 + 880	17	=	21505
	880 + 700	14	=	1106
				200,031



5 10 15 20 25 5 10 15 20 25 5 10 15 20 25 5 10 15 20 25 5 10 15 20 25 5 10 15 20 25 5 10 15 20 25

MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

64

FWPCA

COMPUTATION SHEET

PROJECT _____ SHEET NO. _____ OF _____

SUBJECT _____ BY _____ DATE _____

OFFICE _____ CHECKED BY _____ DATE _____

Colo R nr Dotsero (abv Eagle River)

DATE	TDS[1] MG/L	Colo R blw Eagle[2] CFS	Eagle R[3] CFS	Colo R abv Eagle CFS	Colo R abv Eagle LOAD T/D
9-14-64	198				
10-28	315	750	165	585	497
11-02	278	784	176	608	456
11-16	250	855	200	655	442
11-30	279	860	197	663	499
12-14	308	600	140	460	383
12-21	294	880	178	702	462
01-11-65	242	800	170	630	412
1-25	289	800	163	637	497
2-08	238	755	161	594	382
2-24	275	705	137	568	422
3-10	262	735	145	590	417
3-22	316	766	137	629	537
4-05	233	1190	178	1012	637
4-20	282	1430	310	1120	853
5-03	193	4120	1160	2960	1542
5-21	181	5400	1670	3730	1823
6-01	179	4560	1650	2910	1406
6-14	177	5280	3170	6110	2920
6-28	172	5560	2680	2880	1337
7-12	263	4000	2380	1620	1150
7-26	187	4940	1610	3330	1681
8-02,06	192	4670	1520	3150	1633
8-13	225	2050	577	1473	895
8-23	168	2620	640	1980	898
9-14	246	1280	350	930	618
9-27	250	1620	424	1196	807
10-02	236				
10-25	233				
11-09	218				
11-22	196				
12-10	192				
12-20	194				
1-10	166				
1-24	168				

65<

(1) Field Sta. Data Release
(2) WR Data p205
(3) " " p203

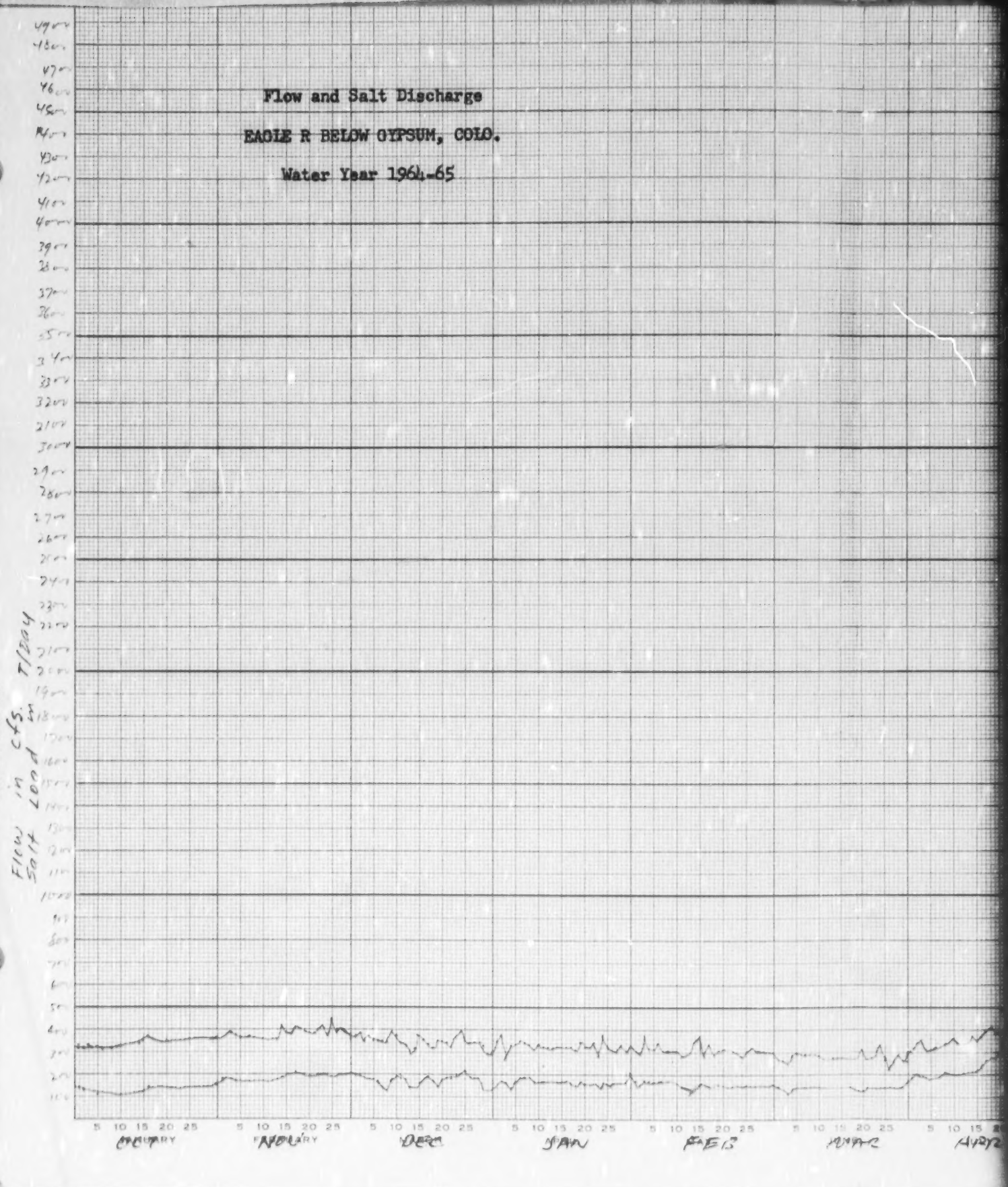
Data - Eagle River below Gypsum, Colo,

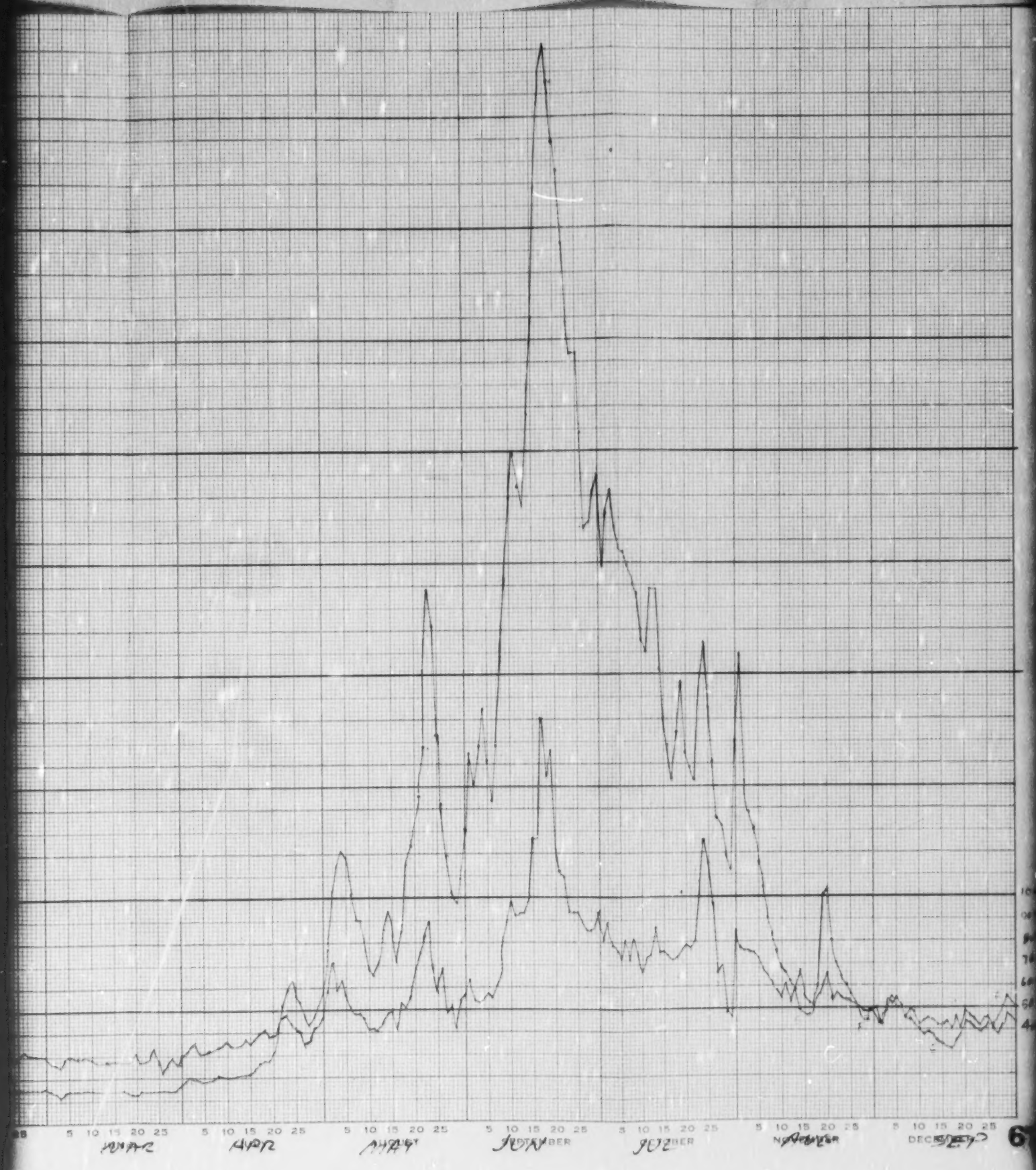
APPENDIX E

Flow and Salt Discharge

EAGLE R BELOW GYPSUM, COLO.

Water Year 1964-65




5 10 15 20 25
5 10 15 20 25
5 10 15 20 25
5 10 15 20 25
5 10 15 20 25
5 10 15 20 25
5 10 15 20 25

9-700. Eagle River below Gypsum, Colo.

Location.--Lat 39°39'00", long 106°57'10", in NW¼ sec.5, T.5 S., R.85 W., on right bank 30 ft downstream from bridge on U. S. Highways 6 and 24 at Gypsum and 150 ft downstream from Gypsum Creek.

Drainage area.--957 sq mi.

Records available.--October 1946 to September 1965.

Gage.--Water-stage recorder. Altitude of gage is 6,270 ft.

Average discharge.--19 years, 582 cfs (421,400 acre-ft per year).

Extremes.--Maximum discharge during year, 5,260 cfs June 18 (gage height, 8.22 ft); minimum daily, 114 cfs Mar. 3.
1946-65: Maximum discharge, 6,580 cfs June 11, 1952; maximum gage height, 9.17 ft June 29, 1957; minimum daily discharge, 110 cfs Feb. 21, 1955, Feb. 3, 1956, Dec. 26, 27, 1962.

Remarks.--Records good except those for periods of ice effect, which are fair. Transmountain diversions above station (see elsewhere in this report). Transbasin diversions above station from Robinson Reservoir (capacity, 2,520 acre-ft) to Tenmile Creek for mining development. Many small diversions for irrigation of hay meadows above station. Records of chemical analyses and water temperatures for the water year 1965 are published in Part 2 of this report as "at Gypsum."

Rating tables, except periods of ice effect (gage height, in feet, and discharge, in cubic feet per second)
(Shifting-control method used Apr. 12-19, July 24 to Sept. 16)

Oct. 1 to Apr. 19		Apr. 20 to Sept. 30			
3.3	105	3.8	230	6.0	2,200
3.5	128	4.2	430	6.5	3,820
3.7	163	4.6	720	7.0	3,470
3.9	215	5.0	1,100	8.0	4,850
4.1	280				

Discharge, in cubic feet per second, water year October 1964 to September 1965

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	170	176	194	176	167	143	183	774	1,650	2,480	2,090	437
2	163	176	197	165	147	*132	200	1,030	1,510	2,720	1,520	412
3	161	181	*188	142	167	114	194	1,160	1,680	2,820	1,380	465
4	161	181	185	*174	*167	134	183	1,310	1,840	2,650	1,310	493
5	153	172	176	185	161	140	178	* 1,180	1,610	2,560	1,170	556
6	151	170	161	188	167	142	176	1,010	1,430	2,550	1,040	500
7	* 151	170	b 140	188	165	138	188	900	1,680	2,480	900	458
8	151	170	b 130	181	161	140	191	900	2,080	2,400	828	444
9	151	172	170	170	159	140	206	783	2,430	2,360	756	430
10	151	172	194	170	153	145	203	680	* 2,790	2,150	690	400
11	151	* 174	183	170	147	142	194	648	2,990	2,100	656	392
12	151	172	176	172	132	143	188	712	2,850	2,380	*619	388
13	153	181	b 140	170	125	140	200	855	2,760	*2,380	577	376
14	157	194	b 140	170	155	138	200	940	3,170	2,020	664	350
15	159	197	172	170	163	140	209	828	3,600	1,800	556	335
16	170	200	183	167	145	140	233	712	4,180	1,680	521	335
17	170	209	172	155	157	138	259	846	4,700	1,530	500	315
18	170	206	143	147	155	130	266	1,170	4,810	1,740	605	350
19	167	197	172	161	151	125	270	1,230	4,650	1,960	1,010	376
20	167	185	181	157	153	122	* 310	* 1,460	4,390	1,650	1,030	444
21	165	183	178	157	153	137	400	1,670	4,250	1,580	801	430
22	165	183	178	163	151	137	521	2,020	3,930	1,530	704	406
23	165	200	197	143	147	137	591	2,390	3,570	1,940	640	394
24	165	191	212	163	137	138	633	2,220	* 3,440	2,140	598	406
25	165	203	194	163	138	132	556	1,730	3,440	1,850	563	430
26	165	206	183	151	143	134	528	1,420	3,080	1,610	521	430
27	165	206	183	151	145	137	465	1,190	2,660	1,370	479	424
28	165	197	183	163	149	138	424	1,020	2,680	1,320	444	437
29	170	200	176	163	-	*138	465	980	2,820	1,190	444	528
30	174	197	b 130	165	----------	153	570	1,090	2,880	1,120	493	500
31	174	----------	b 130	200	----------	174	----------	1,310	----------	1,700	*486	----------
Total	5,016	5,621	5,341	5,160	4,260	4,281	9,384	36,058	89,550	61,760	24,585	12,631
Mean	162	187	172	166	152	138	313	1,163	2,985	1,992	793	421
Ac-ft	9,950	11,150	10,590	10,230	8,450	8,490	18,610	71,520	177,600	122,500	48,760	25,050

Calendar year 1964: Max 2,650 Min 130 Mean 429 Ac-ft 311,700
Water year 1964-65: Max 4,810 Min 114 Mean 722 Ac-ft 522,900

Peak discharge (base, 3,500 cfs).--June 18 (0930) 5,260 cfs (8.22 ft).

* Discharge measurement made on this day.
b Stage-discharge relation affected by ice.

EAGLE RIVER BASIN--Continued

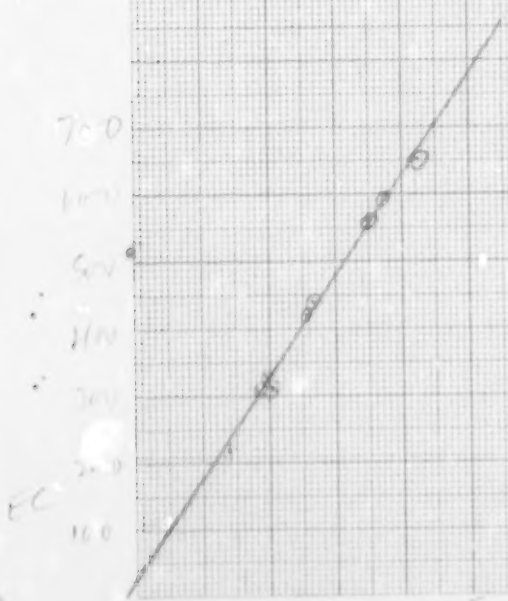
9-690. EAGLE RIVER AT GYPSUM, COLO.--Continued

Specific conductance (micromhos at 25°C), water year October 1964 to September 1965

Day	October	November	December	January	February	March	April	May	June	July	August	September
1.....	1080	1200	1110	1140	1080	1100	994	459	252	221	246	679
2.....	1100	1200	1130	1300	1160	1160	991	423	238	222	320	628
3.....	1140	1230	1090	1130	1300	1270	1050	325	214	193	349	679
4.....	1150	1200	1160	1090	1070	1210	968	330	204	198	360	626
5.....	1220	1210	1160	1050	1100	1200	1020	306	238	198	386	588
6.....	1180	1250	1250	1090	1180	1200	1050	319	254	214	401	615
7.....	1220	1230	1420	1050	1070	1190	1020	339	240	201	442	594
8.....	1240	1260	1500	1070	1070	1220	1040	335	250	227	447	651
9.....	1250	1270	1310	1050	1140	1200	1020	366	244	214	466	661
10.....	1250	1260	1110	1140	1120	1130	976	376	238	210	486	629
11.....	1250	1240	1080	1090	1180	1090	1020	397	211	234	502	680
12.....	1250	1240	1090	1000	1230	1100	1040	354	222	213	592	691
13.....	1240	1140	1210	1080	1310	1130	1070	331	227	242	552	689
14.....	1260	1250	1270	1110	1290	1120	1020	327	217	248	535	711
15.....	1270	1140	1250	1090	1310	1110	1030	368	235	275	537	731
16.....	1260	1140	1130	1110	1150	1120	997	359	208	284	540	756
17.....	1230	1140	1140	1190	1240	1160	930	388	253	301	571	763
18.....	1230	1120	1250	1210	1110	1150	853	280	219	274	566	770
19.....	1240	1140	1220	1230	1170	1400	859	293	238	328	379	640
20.....	1240	1190	1140	1190	1180	1260	745	299	192	304	395	658
21.....	1210	1290	1110	1170	1180	1170	581	291	186	310	413	656
22.....	1230	1170	1040	1210	1150	1170	545	268	194	332	489	669
23.....	1230	1290	1070	1150	1110	1400	494	248	185	349	526	639
24.....	1250	1170	1070	1310	1160	1090	425	210	190	366	557	665
25.....	1230	1150	1060	1140	1270	985	454	224	190	386	564	628
26.....	1220	1110	1080	1210	1310	1080	461	308	201	377	591	582
27.....	1240	1080	1090	1150	1210	1250	478	272	218	309	640	540
28.....	1210	1120	1080	1180	1170	1090	526	317	217	334	653	578
29.....	1220	1100	1070	1090	--	1090	547	275	205	265	644	534
30.....	1220	1090	1290	1080	--	1010	502	317	222	268	593	530
31.....	1200	--	1270	967	--	988	--	281	--	316	602	--
Average	1220	1190	1170	1130	1180	1160	823	322	220	271	494	648

EC = 557

TDS = 367 − 25 = 342 ∠ 3



$y = mx + b$

$= \quad + 25$

$\frac{700 - 25}{445} = m$

$m = 1.516\,854$

$EC = 1.516\,854\,TDS + 25$

$TDS = 0.659\,259\,EC - 25$

FLOW AND QUALITY DATA

EAGLE R BELOW GYPSUM, COLO

WATER YEAR 1964-65

OCTOBER

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	170.	1080.	687.	315.
2	163.	1100.	700.	308.
3	161.	1140.	727.	316.
4	161.	1150.	733.	319.
5	153.	1220.	779.	322.
6	151.	1180.	753.	307.
7	151.	1220.	779.	318.
8	151.	1240.	792.	323.
9	151.	1250.	799.	326.
10	151.	1250.	799.	326.
11	151.	1250.	799.	326.
12	151.	1250.	799.	326.
13	153.	1240.	792.	327.
14	157.	1260.	806.	341.
15	159.	1270.	812.	349.
16	170.	1260.	806.	370.
17	170.	1230.	786.	361.
18	170.	1230.	786.	361.
19	167.	1240.	792.	357.
20	167.	1240.	792.	357.
21	165.	1210.	773.	344.
22	165.	1230.	786.	350.
23	165.	1230.	786.	350.
24	165.	1250.	799.	356.
25	165.	1230.	786.	350.
26	165.	1220.	779.	347.
27	165.	1240.	792.	353.
28	165.	1210.	773.	344.
29	170.	1220.	779.	358.
30	174.	1220.	779.	366.
31	174.	1200.	766.	360.
	5016.			10529.

NOVEMBER

DAY	DISCHARGE * CFS	EC	QUALITY MG/L	T/DAY
1	176.	1200.	766.	364.
2	176.	1200.	766.	364.
3	181.	1230.	786.	384.
4	181.	1200.	766.	374.
5	172.	1210.	773.	359.
6	170.	1250.	799.	367.
7	170.	1230.	786.	361.
8	170.	1260.	806.	370.
9	172.	1270.	812.	377.
10	172.	1260.	806.	374.
11	174.	1240.	792.	372.
12	172.	1240.	792.	368.
13	181.	1140.	727.	355.
14	194.	1250.	799.	418.
15	197.	1140.	727.	386.
16	200.	1140.	727.	392.
17	209.	1140.	727.	410.
18	206.	1120.	713.	397.
19	197.	1140.	727.	386.
20	185.	1190.	760.	379.
21	183.	1290.	825.	408.
22	183.	1170.	746.	369.
23	200.	1290.	825.	446.
24	191.	1170.	746.	385.
25	203.	1150.	733.	402.
26	206.	1110.	707.	393.
27	206.	1080.	687.	382.
28	197.	1120.	713.	379.
29	200.	1100.	700.	378.
30	197.	1090.	694.	369.
	5621.			11466.

DECEMBER

DAY	DISCHARGE * CFS	EI	QUALITY MG/L	T/DAY
1	194.	1110.	707.	370.
2	197.	1130.	720.	383.
3	188.	1090.	694.	352.
4	185.	1160.	740.	369.
5	176.	1160.	740.	351.
6	161.	1250.	799.	347.
7	140.	1420.	911.	344.
8	130.	1500.	964.	338.
9	170.	1310.	839.	385.
10	194.	1110.	707.	370.
11	183.	1080.	687.	339.
12	176.	1090.	694.	329.
13	140.	1210.	773.	292.
14	140.	1270.	812.	307.
15	172.	1250.	799.	371.
16	183.	1130.	720.	356.
17	172.	1140.	727.	337.
18	143.	1250.	799.	308.
19	172.	1220.	779.	362.
20	181.	1140.	727.	355.
21	178.	1110.	707.	340.
22	178.	1040.	661.	317.
23	197.	1070.	680.	362.
24	212.	1070.	680.	389.
25	194.	1060.	674.	353.
26	183.	1080.	687.	339.
27	183.	1090.	694.	343.
28	183.	1080.	687.	339.
29	176.	1070.	680.	323.
30	130.	1290.	825.	290.
31	130.	1270.	812.	285.
	5341.			10647.

JANUARY

DAY	DISCHARGE * CFS	EC	QUALITY MG/L	T/DAY
1	176.	1140.	727.	345.
2	165.	1300.	832.	371.
3	142.	1130.	720.	276.
4	174.	1090.	694.	326.
5	185.	1050.	667.	333.
6	188.	1090.	694.	352.
7	188.	1050.	667.	339.
8	181.	1070.	680.	332.
9	170.	1050.	667.	306.
10	170.	1140.	727.	333.
11	170.	1090.	694.	318.
12	172.	1080.	687.	319.
13	170.	1080.	687.	315.
14	170.	1110.	707.	324.
15	170.	1090.	694.	318.
16	167.	1110.	707.	319.
17	155.	1140.	760.	318.
18	147.	1210.	773.	307.
19	161.	1230.	786.	341.
20	157.	1190.	760.	322.
21	157.	1170.	746.	316.
22	163.	1210.	773.	340.
23	143.	1150.	733.	283.
24	163.	1310.	839.	369.
25	163.	1140.	727.	320.
26	151.	1210.	773.	315.
27	151.	1150.	733.	299.
28	163.	1180.	753.	331.
29	163.	1090.	694.	305.
30	165.	1080.	687.	306.
31	200.	967.	613.	331.
	5160.			10028.

FEBRUARY

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	167.	1080.	687.	310.
2	147.	1160.	740.	293.
3	167.	1300.	832.	375.
4	167.	1070.	680.	307.
5	161.	1100.	700.	304.
6	167.	1180.	753.	339.
7	165.	1070.	680.	303.
8	161.	1070.	680.	296.
9	159.	1140.	727.	312.
10	153.	1120.	713.	295.
11	147.	1180.	753.	299.
12	132.	1230.	786.	280.
13	125.	1310.	839.	283.
14	155.	1290.	825.	345.
15	163.	1310.	839.	369.
16	145.	1150.	733.	287.
17	157.	1240.	792.	336.
18	155.	1110.	707.	296.
19	151.	1170.	746.	304.
20	153.	1180.	753.	311.
21	153.	1180.	753.	311.
22	151.	1150.	733.	299.
23	147.	1110.	707.	280.
24	137.	1160.	740.	274.
25	138.	1270.	812.	303.
26	143.	1310.	839.	324.
27	145.	1210.	773.	302.
28	149.	1170.	746.	300.
	4260.			8635.

MARCH

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	143.	1100.	700.	270.
2	132.	1160.	740.	264.
3	114.	1270.	812.	250.
4	134.	1210.	773.	279.
5	140.	1200.	766.	289.
6	142.	1200.	766.	294.
7	138.	1190.	760.	283.
8	140.	1220.	779.	294.
9	140.	1200.	766.	289.
10	145.	1130.	720.	282.
11	142.	1090.	694.	266.
12	143.	1100.	700.	270.
13	140.	1130.	720.	272.
14	138.	1120.	713.	266.
15	140.	1110.	707.	267.
16	140.	1120.	713.	270.
17	138.	1160.	740.	276.
18	130.	1150.	733.	257.
19	125.	1400.	898.	303.
20	122.	1260.	806.	265.
21	137.	1170.	746.	276.
22	137.	1170.	746.	276.
23	137.	1400.	898.	332.
24	138.	1090.	694.	258.
25	132.	985.	624.	222.
26	134.	1080.	687.	248.
27	137.	1250.	799.	295.
28	138.	1090.	694.	258.
29	138.	1090.	694.	258.
30	153.	1010.	641.	265.
31	174.	988.	626.	294.
	4281.			8490.

APRIL

DAY	DISCHARGE * CFS	QUALITY EC.	MG/L	T/DAY
1	183.	994.	630.	311.
2	200.	991.	628.	339.
3	194.	1050.	667.	349.
4	183.	968.	613.	303.
5	178.	1020.	647.	311.
6	176.	1050.	667.	317.
7	188.	1020.	647.	329.
8	191.	1040.	661.	341.
9	206.	1020.	647.	360.
10	203.	976.	618.	339.
11	194.	1020.	647.	339.
12	188.	1040.	661.	335.
13	200.	1070.	680.	367.
14	200.	1020.	647.	349.
15	209.	1030.	654.	369.
16	233.	997.	632.	398.
17	259.	930.	588.	411.
18	266.	853.	537.	386.
19	270.	859.	541.	394.
20	310.	745.	466.	390.
21	400.	581.	358.	387.
22	521.	545.	334.	470.
23	591.	494.	301.	480.
24	633.	425.	255.	436.
25	556.	454.	274.	412.
26	528.	461.	279.	397.
27	465.	478.	290.	364.
28	424.	526.	322.	368.
29	465.	547.	336.	421.
30	570.	502.	306.	471.
	9384.			11243.

78<

MAY

DAY	DISCHARGE CFS	* EC	QUALITY MG/L	T/DAY
1	774.	459.	278.	580.
2	1030.	423.	254.	706.
3	1160.	325.	189.	593.
4	1210.	330.	193.	629.
5	1180.	306.	177.	563.
6	1010.	319.	185.	505.
7	900.	339.	198.	482.
8	900.	335.	196.	476.
9	783.	366.	216.	457.
10	680.	376.	223.	409.
11	648.	397.	237.	414.
12	712.	354.	208.	400.
13	855.	331.	193.	446.
14	940.	327.	191.	484.
15	828.	368.	218.	486.
16	712.	359.	212.	407.
17	846.	388.	231.	527.
18	1170.	280.	160.	504.
19	1230.	293.	168.	558.
20	1460.	299.	172.	678.
21	1670.	291.	167.	752.
22	2020.	268.	152.	827.
23	2380.	248.	138.	890.
24	2220.	210.	113.	680.
25	1730.	224.	123.	573.
26	1420.	308.	178.	682.
27	1190.	272.	154.	496.
28	1020.	317.	184.	507.
29	980.	275.	156.	413.
30	1090.	317.	184.	541.
31	1310.	281.	160.	567.
	36058.			17230.

JUNE

DAY	DISCHARGE * CFS	QUALITY FC	MG/L	T/DAY
1	1650.	252.	141.	629.
2	1510.	238.	132.	538.
3	1680.	214.	116.	526.
4	1840.	204.	109.	544.
5	1610.	238.	132.	573.
6	1430.	254.	142.	550.
7	1680.	240.	133.	604.
8	2080.	250.	140.	785.
9	2430.	244.	136.	891.
10	2790.	238.	132.	993.
11	2990.	211.	114.	921.
12	2850.	222.	121.	933.
13	2750.	227.	125.	929.
14	3170.	217.	118.	1010.
15	3600.	235.	130.	1262.
16	4180.	208.	112.	1265.
17	4700.	253.	142.	1799.
18	4810.	219.	119.	1550.
19	4650.	238.	132.	1655.
20	4390.	192.	102.	1204.
21	4250.	186.	98.	1120.
22	3930.	194.	103.	1091.
23	3570.	185.	97.	934.
24	3440.	190.	100.	931.
25	3440.	190.	100.	931.
26	3080.	201.	108.	894.
27	2660.	218.	119.	852.
28	2680.	217.	118.	854.
29	2820.	205.	110.	838.
30	2880.	222.	121.	943.
	89550.			28549.

80<

JULY

DAY	DISCHARGE CFS	* EC	QUALITY MG/L	T/DAY
1	2480.	221.	121.	808.
2	2720.	222.	121.	891.
3	2820.	193.	102.	778.
4	2650.	198.	106.	755.
5	2560.	198.	106.	729.
6	2550.	214.	116.	799.
7	2480.	201.	108.	720.
8	2400.	227.	125.	807.
9	2360.	214.	116.	739.
10	2150.	210.	113.	658.
11	2100.	234.	129.	733.
12	2380.	213.	115.	741.
13	2380.	242.	135.	864.
14	2020.	248.	138.	755.
15	1800.	275.	156.	759.
16	1680.	284.	162.	736.
17	1530.	301.	173.	716.
18	1740.	274.	156.	731.
19	1960.	328.	191.	1012.
20	1650.	304.	175.	781.
21	1580.	310.	179.	765.
22	1530.	332.	194.	801.
23	1940.	349.	205.	1074.
24	2140.	366.	216.	1249.
25	1850.	386.	229.	1146.
26	1610.	377.	224.	971.
27	1370.	309.	179.	661.
28	1320.	334.	195.	695.
29	1190.	265.	150.	481.
30	1120.	268.	152.	459.
31	1700.	316.	183.	841.
	61760.			24655.

AUGUST

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	2090.	246.	137.	774.
2	1520.	320.	186.	763.
3	1380.	349.	205.	764.
4	1310.	360.	212.	751.
5	1170.	386.	229.	725.
6	1040.	401.	239.	672.
7	900.	442.	266.	647.
8	828.	447.	270.	603.
9	756.	466.	282.	576.
10	680.	486.	295.	542.
11	656.	502.	306.	542.
12	619.	592.	365.	610.
13	577.	552.	339.	528.
14	654.	535.	328.	587.
15	556.	537.	329.	494.
16	521.	540.	331.	465.
17	500.	571.	351.	474.
18	605.	566.	348.	568.
19	1010.	379.	225.	613.
20	1030.	395.	235.	654.
21	801.	413.	247.	535.
22	704.	489.	297.	565.
23	640.	526.	322.	556.
24	598.	557.	342.	552.
25	563.	564.	347.	527.
26	521.	591.	365.	513.
27	479.	640.	397.	513.
28	444.	653.	405.	486.
29	444.	644.	400.	479.
30	493.	593.	366.	487.
31	486.	602.	372.	488.
	24585.			18052.

SEPTEMBER

DAY	DISCHARGE * CFS	QUALITY EC	MG/L	T/DAY
1	437.	679.	423.	498.
2	412.	628.	389.	433.
3	465.	679.	423.	530.
4	493.	626.	388.	516.
5	556.	588.	363.	544.
6	500.	615.	380.	513.
7	458.	594.	367.	453.
8	444.	651.	404.	484.
9	430.	661.	411.	477.
10	400.	629.	390.	421.
11	382.	680.	423.	436.
12	388.	691.	431.	451.
13	376.	689.	429.	436.
14	350.	711.	444.	419.
15	335.	731.	457.	413.
16	335.	756.	473.	428.
17	315.	763.	478.	406.
18	350.	770.	483.	456.
19	376.	640.	397.	403.
20	444.	658.	409.	490.
21	430.	656.	407.	473.
22	406.	669.	416.	456.
23	394.	639.	396.	421.
24	406.	665.	413.	453.
25	430.	628.	389.	451.
26	430.	582.	359.	416.
27	424.	540.	331.	379.
28	437.	578.	356.	420.
29	528.	534.	327.	466.
30	500.	530.	324.	438.
	12631.			13582.

SUMMARY

MONTH	DISCHARGE AF/YR	SALT LOAD T/YR
OCT	9949.	10529.
NOV	11149.	11466.
DEC	10594.	10647.
JAN	10235.	10028.
FEB	8450.	8635.
MAR	8491.	8490.
APR	18613.	11243.
MAY	71520.	17230.
JUN	177620.	28549.
JUL	122499.	24655.
AUG	48764.	18052.
SEP	25053.	13582.
	522936.	173107.